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MAYFLIES OF NORTH CAROLINA

Part III. The Heptageninae

By Jay R. Traver

Plate 15

In previous papers (Jour. Elisha Mitchell Sci. Soc. **47**: Nos. 1 and 2) I have recorded the species of mayflies of the subfamilies Ephemerinae and Baetinae, which I have taken in North Carolina. The remaining subfamily, Heptageninae, is treated in like manner here. In the keys presented at the beginning of this faunistic study (op. cit., p. 101), these three subfamilies were characterized. Further study has led me to believe that I was in error in following the traditional identification of some of the genera of this last subfamily. A more extended account of my present conception of this subfamily will appear in the near future, in the Journal of the N. Y. Ent. Society. I give here, therefore, merely a brief summary of that portion of the article which immediately concerns the North Carolina species, with a correction of my previous errors, and with revised keys to the North Carolina genera of this subfamily.

The word Heptagenia, as used in my previous paper (op. cit., p. 101), should be changed to Stenonema, and the word Ecdyonurus to Heptagenia. Examination of specimens of the type species of Ecdyonurus has convinced me that this word has been misapplied to those North American species which I now call Stenonema. I believe now that none of my North Carolina species belong to the genus Epeorus, but that all should be referred to Iron. I refer the reader to the more ex-

tended article in the JOURNAL, where I have set forth in detail my reasons for the above changes. The revised and corrected keys to the subfamily Heptageninae are as follows.

Key to the male imagoes

1. First joint of fore tarsus considerably shorter than second joint (never more than ⅔ of second, often much shorter).....2
   First joint of fore tarsus equal to second joint, or slightly exceeding it in length.....*Iron*
2. First joint of fore tarsus very short (⅛ to ¼ of second).....3
   First joint of fore tarsus longer (½ to ⅔ of second).....*Stenonema*
3. Lobes of penes separated from one another very near the base, thus appearing as two long narrow projections. Cross veins in stigmatic region tend to anastomose.....*Rhithrogena*
   Lobes of penes joined together except near apex; broad, often somewhat angular laterally and distally; never as above. Cross veins of stigmatic region not anastomosed.....*Heptagenia*

Key to the nymphs

1. Tails two, in mature nymph.....*Iron*
   Tails three, in mature nymph.....2
2. Gills of seventh pair tapered threads or spines; tracheae, if present in these, without lateral branches.....*Stenonema*
   Gills of seventh pair flat and plate-like; tracheae always present in these, and with lateral branches.....3
3. Gills of first and last pairs much enlarged, converging beneath the body *Rhithrogena*
   Gills of first and last pairs not as large as some of central pairs; directed laterally, not converging beneath body.....4
4. Postero-lateral margins of pronotum prolonged backwards into epaulet-like extensions.....*Ecdyonurus*
   Postero-lateral margins of pronotum not prolonged backwards.....*Heptagenia*

Genus HEPTAGENIA Walsh 1863

Although twenty-seven species of this genus have been described from North America, only six species appear in my collections from North Carolina. Two of these are new. It should be noted here that those species previously described or listed from North Carolina by Eaton and Banks, as Heptagenia, now fall into the genus Stenonema.

No representatives of this genus were found in the coastal plain region. The following keys may be useful in distinguishing the nymphs and imagoes of these species.

Key to male imagoes—Heptagenia—North Carolina species

1. Genitalia of the *maculipennis* type (see Fig. 15). Basal costal cross veins, sometimes other cross veins, margined with brown or black.....2
   Genitalia not of the *maculipennis* type. Basal costal cross veins not dark-margined.....3
2. All veins in posterior half of forewing colorless. Abdominal tergites unmarked except dark posterior margins.....*juno*
   Cross veins in posterior half of forewing brown. Abdominal tergites marked laterally with broad brown patches.....*aphrodite*
3. Veins colorless. Size under 6 mm.....*spinosa*
   Veins brown. Size 7 mm. or over.....4
4. Genitalia of the *flavescens* type (see Fig. 8). Abdomen with black oblique lateral stripes, no dark median dorsal band.....*marginalis*
   Genitalia of the *elegantula* type (see Fig. 1). Abdomen with broad dark median dorsal band, no black lateral stripes.....*julia*

Key to nymphs—Heptagenia—North Carolina species

1. Filaments present on gills of seventh pair. Pronotum widest at anterior margin.....2
   Filaments absent from gills of seventh pair. Pronotum widest at middle...3
2. Abdomen with oblique black lines on each side of tergites. Very short lateral spines on segments 6 and 7.....*marginalis*
   Abdomen without oblique black lateral lines. No lateral spines on segments 6 and 7.....*julia*
3. Three small light spots on each side of frontal margin of head. Tergite 8 and anterior half of 9, largely white.....*aphrodite*
   No light spots on frontal margin of head. Tergites 8 and 9 without such a prominent white blotch.....4
4. Sternites 8 and 9 with dark transverse bars.....*juno*
   Sternites 8 and 9 without dark transverse bars.....sp?

From the piedmont region

Heptagenia marginalis Bks.

This was the most common species of Heptagenia in the piedmont, although not abundant at any place. Mature nymphs were collected and reared from several stations, so that the identity of the species and the correct association between nymph and imago was established. Collections were as follows. Near Denton, May 14, 1929; Caraway Creek near Sophia, May 11–17, and Sept. 29, 1929, and May 20, 1930; Big Alamance Creek, Sept. 30 to Oct. 14, 1929; and Little Alamance Creek, Sept. 8, 1929.

Heptagenia aphrodite McD.

Nymphs of this species were taken from two stations and nymphs reared from them. On Oct. 1, 1929, a female was reared from Big Alamance Creek. Nymphs were likewise reared from Caraway Creek near Sophia on May 1, 1929; Sept. 28, 1929; and May 11–24, 1930. I present the following description of the nymph.

Nymph

Size—Body 6–6½ mm.; tails broken, in all specimens.

General color—Dorsally, brown with cream-white markings. Ventrally, creamy white to light tan.

Head—Many small round brown spots (or papillae?) along frontal border. Light-colored bar from outer anterior margin of eye to lateral border. Small white spot anterior to each ocellus. On margin of frons, three small white spots on each side, the posterior ones larger. Three white spots on each side of vertex near inner margin of eye. Base of antenna light brown, greyish white distally. Mouthparts very similar to Eaton's figure of a nameless North American nymph (Monograph, Pl. 59). The labrum, however, is slightly emarginate in front, and its lateral extensions do not turn downward so sharply. Right mandible with 4 long slender hairs on upper margin at base of inner canine; 3 such hairs on left mandible. 15 to 16 pectinate spines on crown of maxilla.

Thorax—Pronotum widest at middle. Lateral margins colorless. White mark like an inverted L, its base on anterior margin, on each side. Between this and the colorless margin, a brown bar followed by a light one. Curving white mark along center of posterior margin. Many small irregular white marks on mesonotum, including an L-shaped mark between the wing roots, and a round spot anterior to each wing root.

Legs—Femur white at base and tip, with white extensions into main brown portion from basal area. Two round white spots on hind margin, two smaller ones on forward margin, and two in central area. Hind margin fringed with long tawny hairs. Many small brown to orange spines on upper surface. Femoral flange short (not extending out beyond remainder of femur). Tibia light brown, with wide median and apical white bands. Hind margin fringed with hairs. Tarsus light brown basally, white apically. Claw with usual median spine on inner margin, less well developed than in *marginalis*. In addition, three slender teeth or spines near tip (i.e., claw is pectinate).

Abdomen—Lateral margins of 3–7 extended. Postero-lateral spines present on 3–8; very short on 3, increasing in length to 6; 7 somewhat shorter than 6; 8 shorter than 7 but longer than 3. Dorsally, segment 1 largely white, with narrow brown transverse band near posterior margin, and brown laterally. Segments 2, 3, 8, and 10 largely brown. White submedian marks on 2, 3, and 6, and other white marks near posterior margin and nearer the lateral border. Anterior half of lateral border white. Segment 10 is narrowly lighter on anterior margin and on each side of dark median line. Segments 4, 5, and 7 have large white central areas bordered on all sides by irregular brown blotches. Lateral margins as in 2–3; irregular brown longitudinal band parallel to lateral margin. Segment 8 and anterior half of 9 dark brown. Ventrally, immature nymphs are creamy white, mature ones light tan, with faint traces of darker longitudinal bars on each side.

Gills—Seventh gill lacks lower filamentous portion. Filaments of lower portion of other gills not as well developed as in *marginalis*. Plate-like parts greyish to light purple; tracheae and filaments purple.

Tails—Light tan at base, becoming somewhat lighter distally. Joinings dark brown, alternate joinings wider.

Heptagenia juno McD.

This species was found in one locality only. Nymphs collected on May 3, 1930, at the Cascades, near Danbury, in the Sauratown Mts., transformed from May 4 to May 19. Several specimens of both sexes were reared. The description of the nymph follows. In general structural characters it agrees with *aphrodite*, both species belonging to the *maculipennis* group.

Nymph

Size—Body of female, 6½ to 7 mm.; tails 11 mm.

General color—Light reddish brown dorsally, creamy white to pale yellowish ventrally.

Head—Small white dots along frontal margin, less prominent than in *aphrodite*. Small white spot anterior to each ocellus. Narrow white bar from outer anterior margin of each eye to lateral margin of head. Small light spot on each side of vertex, about at middle. Antenna reddish brown. Mouthparts very similar to *aphrodite*. 8 slender hairs at base of inner canine on right mandible, 7 on left mandible. About 20 pectinate spines on crown of maxilla.

Thorax—Pronotum widest at middle. Narrow colorless area on lat-

eral margins. Median line narrowly white. Rounded white blotch on each lateral anterior margin. Smaller hour-glass-shaped white mark near middle on each side. Mesonotum with several irregular white marks; a horse-shoe-shaped mark near wing roots; between wing roots a wedge-shaped mark, its base directed posteriorly, enclosing a small dark spot. White blotch at wing roots.

Legs—Femur narrowly whitish at base and apex. One round and one oblong white mark near, but not on, hind border. One to three small rounded marks in central area. One to three small light marks along fore border. Hind border fringed with long hairs. Spines on upper surface longer than in *aphrodite*. Tibia and tarsus reddish brown, no white marks. Tibia fringed with hairs on hind margin. Claw very similar to that of *aphrodite*. Femoral flange projects beyond main body of femur.

Abdomen—Postero-lateral spines as in *aphrodite*. Dorsally, segments 9 and 10 entirely brown. Segments 3 and 6 almost entirely brown, with small light marks only in lateral margins, and a white triangle on each side near the posterior margin halfway between median line and lateral border. Segment 1 largely white. Segments 2, 4, and 5 with white marks as on 3 and 6, and in addition two larger submedian marks, confluent apically, arising from posterior margin. Segments 7 and 8 quite similar to 4 and 5, but white submedian marks are shorter and broader. Ventrally pale yellow on apical segments, whitish on proximal ones. Segment 9 with dark brown lateral margin and transverse brown bar on anterior margin, usually discontinuous on median line. Two dark brown submedian spots on anterior margin of sternite 8, connected by a brown bar. Traces of similar marks on 7 are sometimes present. Extreme edge of lateral margins of all segments dark brown.

Gills—Structurally as in *aphrodite*. An area posterior to center of each plate-like portion purple, the margins light grey. Tracheae not distinct. Filaments light grey.

Tails—Amber yellow to light tan. Joinings reddish brown, alternately wide and narrow.

From the mountain region

Heptagenia marginalis Bks.

While not as common as *H. julia* n. sp., *marginalis* was quite well represented throughout the mountainous portion of the state. Collections from this area are listed. Davidson River, June 18, 1929; Ocona

Lufty River, June 22, 1930; Cullasaja River near Franklin, July 3, 1929; South Toe River at Micaville, July 6, 1930; Bald Creek near Burnsville, July 6, 1930; Spring Creek near Hot Springs, July 11, 1930; Little River near Penrose, July 12, 1930; and Toxaway River near the falls, July 16, 1930.

Specimens were reared in May, and again in September and October, from the piedmont. In the mountains, July was the time of emergence.

Since the nymph of this species does not seem to have been described, I give a description of it, as well as a figure of the male genitalia (Fig. 8). The species would seem to be rather close to *flavescens* Wlsh., the genotype, if similarity in structure of genitalia is any criterion, as I believe it to be. Since the nymph of the genotype is not known, it is not possible to compare this species with it, but I do not doubt that the two will be found quite similar in structural details.

Nymph

Size—Body of male, 9½–10 mm.; female, 11 mm. Tails of female, 22 mm.

General color—Light brown dorsally, creamy white ventrally.

Head—White spots laterad of each lateral ocellus and between the ocelli. Smaller white spot anterior to median ocellus. Small white spot anterior to each compound eye, another at inner margin. Epicranial suture white. Small light spot at middle of vertex. Antenna brown. Mouthparts very similar to figures by Eaton (Monograph, Pl. 61) for a species listed as Ecdyonurus.

Thorax—Pronotum widest at anterior margin. White spots (1) at middle of lateral margin; (2) at center of anterior margin; (3) irregularly along posterior margin; and (4) large area at middle of segment on each side of median line. Black longitudinal lines and scroll-like markings enclose the central white area. Oval white spot at middle of mesonotum on each side of median line, and another anterior to wing roots. Wing-cases brown, whitish at roots.

Legs—Femur brown, with three zigzag transverse bands, at middle and near each end. Femoral flange prominent, rounded apically. Upper surface of femur thickly set with short spines. Hind margin fringed with relatively long hairs. Tibia brown with distal and median white bands. (One specimen, entire distal half white.) Hairs on hind margin. Tarsus brown, lighter distally. Claw white, its tip orange. Usual median spine on inner margin, but no teeth at tip (i.e., not pectinate).

Abdomen—Dorsally, each segment narrowly black on posterior margin. Segment 1 largely white. Segments 2–8 with a longitudinal black stripe midway between median line and lateral margin, on each side. On 2–7, white submedian dash on each side near middle of segment. Lateral margins white, except for brown postero-lateral angles. Round white spot between lateral margin and longitudinal black stripe (very small on 5). Large irregular creamy white blotch on middle area of segment 8. Smaller light spot at middle of 9, on each side of brown median bar. White streak on each side of brown median line on 10. Lateral margins of 1–7 expanded, with very short postero-lateral spines. Ventrally creamy white, tinged with yellow on apical segments.

Gills—Filamentous lower portion present on all gills, well developed. Upper plate-like portion light grey with purple tracheae. Filaments purple.

Tails—Brown. Alternate segments with creamy white joinings. Except near base, a white blotch covering one or two segments alternates with three or four brown segments. Pale amber at extreme tip.

Heptagenia aphrodite McD.

A male and several females were taken in flight as subimagoes over Flat Creek, at Black Mountain, on June 30, 1930. These transformed to imagoes. Nymphs taken from this stream were similar to those reared from the piedmont. A somewhat darker male, taken in flight near Waynesville, is tentatively referred to this species, but may belong with the female listed as *Heptagenia* sp. Nymphs were found likewise at Laurel River not far from Hot Springs on June 29, 1930.

Heptagenia sp.? (*maculipennis* group)

A female nymph, taken in a tributary of the Pigeon River four miles west of Hazelwood, transformed on July 24, 1929. Although this species is a member of the *maculipennis* group, the nymph differs from *juno* and also from *aphrodite*. Another nymph of this species was taken in Hominy Creek near Canton on July 18, 1930.

Female imago

Size—Body 7½ mm.; wing 8½ mm.

Head—Margin of clypeus dark.

Thorax—Pronotum marked with greyish brown. Remainder of thorax yellowish, with a few lateral brown marks.

Legs—Pale. Fore femur with median brown band and brown at distal end. Black streak on distal third, on inner margin.

Wings—Three basal costal cross veins, two at bulla, and three subcostals at bulla, brown-margined. Other veins dark brown.

Abdomen—Largely orange brown, paler ventrally. Each tergite has an irregularly rhomboidal dark lateral patch, rather as in *aphrodite*, but more extensive. Tergites 2 and 3 dark. 4–6 have large light median patches, and short submedian dark marks. Tails white, unmarked.

Nymph

Head and *thorax* very similar to *juno*.

Legs—Femur pale, with three dark transverse bands. Fringed on hind margin with long hairs. Short spines on upper surface. Tibia light brown, tarsus darker brown, both unmarked. Three pectinations on claw.

Abdomen—Tergites 2, 3, 6, and 9 largely brown, the two latter very dark. Tergite 1 largely pale. Remaining tergites brown basally, whitish in apical half. Apical margin of brown area irregularly scalloped. Ventral surface unmarked except for narrow brown lateral border on sternite 9. Gills much as in *juno*. Tails yellow, joinings dark brown.

? *Male imago*

It is possible that the dark male taken at Waynesville on July 17, and tentatively listed as *aphrodite*, may really belong to this species. Genitalia of this male are very similar to *aphrodite* (see Fig. 15).

Somewhat similar nymphs were taken from the Ocona Lufty River on June 2, 1930, and from the Rocky Broad River at Lecky Gap on June 23, 1930. None were reared. These may represent still another species of the *maculipennis* group.

Heptagenia julia, sp. nov.

This species is close to *pulla* Clem., but smaller. I had at first considered it to be *pulla*, but think now that it is a distinct species. Thorax reddish brown dorsally. Abdomen pale yellowish, semi-hyaline, the tergites purplish along median line. Segments 8–10 deeper yellow, opaque.

Male imago

Size—Body 7–8½ mm.; wing 7½–8¼ mm.; tails 12–19 mm.

Head—Pale yellowish, tinged with reddish brown on vertex. Narrow

black transverse line on each side of front, extending out from compound eye. Antenna pale yellowish brown. Bases of ocelli black.

Thorax—Pronotum light reddish brown, with lateral purplish brown area. Posterior margin narrowly black at center. Meso- and metanota darker reddish brown, the tips of the spines very dark. Pleura yellowish. Conspicuous round black spot above fore coxa. Black line on mesonotum anterior to and below wing roots. Black lines anterior to middle and hind coxae; purplish line posterior to each. Pale yellow ventrally, except posterior half of mesosternum, which is yellowish brown.

Legs—First fore tarsal joint about $\frac{1}{4}$ of second. Fore leg dusky. Fore femur with indistinct purplish median band. Distal end purplish brown. Remainder of leg tinged with same color. Black streak on inner margin of distal fourth of fore femur. Tibio-tarsal joining and joinings of tarsus narrowly darker. Black streak on inner margin of first tarsal joint. Femora of other legs pale yellowish with indistinct dusky tinge; narrowly darker at distal end. Tibiae and tarsi dusky.

Wings—Semi-hyaline. Stigmatic area opaque. All veins light brown, the three large veins of the costal margin somewhat yellowish

Abdomen—Segments 1–7 pale yellowish, semi-hyaline. Segments 8–10 yellowish red, paler ventrally; opaque. Posterior margins of all tergites narrowly purplish black. Tergites 1–4 with wide median purplish band, becoming wider posteriorly on each tergite. Median purplish band on tergites 5–7 also, but somewhat narrower. Whitish submedian blotches within this purple band, on each tergite. In tergites 1 and 2, these are based on anterior margin, but are nearer the center on tergites 3–7. Minute black line at stigma in each segment. Unmarked ventrally.

Tails—Dusky at base, becoming pale yellowish brown distally. Joinings dull purplish, except three or four at base which are pale. These purple bands alternately wide and narrow in basal third.

Genitalia—Of the *elegantula* type. Very close to *pulla* Clem., but distinguished by smaller size and slight structural differences. Forceps and penes dusky, subanal plate yellowish. See Fig. 11. The apical projections of the penes are more acute than in *pulla*, and the two central pairs of spines differ as follows. In *pulla*, the lower pair is very long and stout, the upper pair shorter and somewhat curved. In *julia*, both pairs of spines are nearly alike in size and shape. The second joint of the forceps of *pulla* is likewise longer relatively than in *julia*. I figure also the genitalia of *pulla* (Fig. 1). This is a camera lucida sketch from

a slide which Dr. McDunnough kindly lent me for comparison with *julia*.

Female imago

Very similar to male imago. Somewhat paler. Abdomen opaque, flushed with pink before eggs are deposited. Body 7–8½ mm.; wing 8–10 mm.; tails 13–16 mm.

Nymph

Size—Body of female, 8–9 mm.; tails 15–17 mm.

General color—Dark reddish brown dorsally, creamy white to pale yellow ventrally.

Head—Large white spot anterior to each ocellus. Small white spot on each side of vertex, posterior to each lateral ocellus. Another white spot on median line at center of vertex. Epicranial suture white. Narrow white line from outer anterior margin of eye to lateral border of head. Basal sclerite of antenna white. Filament pale brown basally, whitish distally. Mouthparts very similar to *marginalis* Bks.

Thorax—Pronotum widest at anterior margin. Somewhat crescent-shaped white area at center of anterior margin of pronotum. White spot in each anterior lateral angle. Irregular L- shaped white mark at middle of each side. Lateral margins narrowly colorless. Mesonotum with white streak on median line, widest at anterior margin. Small white spot anterior to each wing root. Slender elongate or oblong white mark on each side between wing roots, near median line. Laterad of this, another small oval white spot.

Legs—Femur narrowly light at base. Three rather irregular light bands, at middle and near each end, often not extending the width of the femur. Narrow white border, wider at each end, along basal half of hind margin. Two brown blotches on lower surface, at hind margin. Femoral flange projects beyond body of femur; rounded apically. Femur fringed with rather long hairs on hind margin. Upper surface with short brown spines. White band on tibia just before the middle, another at distal end. Hind margin fringed. Tip of tarsus white. Claw orange at tip, elsewhere white. Not pectinate.

Abdomen—Lateral margins of 1–7 slightly produced, but lacking definite spines. Each tergite with purplish black posterior margin. Rather broad dark band on median line of tergites 1–7, and basal half of 8. White submedian marks on each tergite, also a small white spot at middle on each side, halfway to lateral margin. Large white blotch

at center of lateral margin. In some specimens the submedian marks on 4 and 8 (not 4–8) are connected posteriorly, thus resembling *pulla* Clem. In many other specimens this is not the case. Tergite 10 has only the submedian light marks. Ventrally creamy white to pale yellow, the apical segments more often tinged with yellow. Sternites 8 and 9 with dark brown lateral border, forming a wide bar on 9. Traces, more or less distinct, of a dark longitudinal line parallel to lateral margin, on each side of body.

Gills—Seventh pair with filaments. Gill plates grey, tracheae and filaments purple.

Tails—Light brown at base, becoming darker distally. Joinings darker. Except at base and tip, each alternate two (or three) segments are dark, the next two lighter. Tip lighter brown, no such alternating dark and light patches.

Holotype—Male imago, reared. North Fork of Swannanoa River near Black Mountain, N. C., July 3, 1930. No. 1114.1 in Cornell University collection.

Allotype—Female imago, reared. Tributary of Pigeon River four miles west of Hazelwood, N. C., July 21, 1930. No. 1114.2 in Cornell collection.

Paratypes—8 male imagoes, 17 female imagoes. Waynesville, N. C., July 20–26, 1929; Allen's Creek near Hazelwood, July 18 and 24, 1929; Flat Creek at Black Mountain, July 2, 1930; Rocky Broad River at Lecky Gap, July 2 and 6, 1930; tributary of Pigeon River west of Hazelwood, July 27 and Aug. 2, 1930; tributary of Davidson River in Pisgah Forest, July 17, 1930; and tributary of the French Broad River at Selica, July 15, 1930. No. 1114.3–27.

This species differs from *pulla* Clem. (1) in its smaller size; (2) in structural details of penes as already noted; (3) darker color of legs and tails of imagoes; (4) the presence of a black line in the stigma of each tergite; and (5), the slight color differences in the pattern of the nymph. (One specimen was noted in which legs and tails were as light in color as in *pulla*.) Its habitat likewise is different. Clemens writes of *pulla* (Canad. Ent. **45**: 33), "the nymphs were found along the very stony, exposed shores of small islands three and four miles out in the open bay" (Georgian Bay). Nymphs of *julia*, on the contary, were the commonest species of Heptagenia in the mountains of the state, found in practically all the streams, both large and small, of that area. The

wide distribution of the species in the state is indicated by the following localities (other than those listed for the types): Swannanoa River at Black Mountain; Catawba River near Andrews Geyser; small stream near Fairview; tributary of the Rocky Broad at Bottomless Pools; Davidson River and one of its tributaries; tributary of the Cullasaja River near Franklin; tributary of the Tuckaseegee River on Cowee Mountain; tributary of Laurel River near Hot Springs; tributary of the Nantahala River near Topton; Wayah Creek near Franklin; Bald Creek near Burnsville; tributary of the North Fork of the Catawba River near Woodlawn; Conestee Creek; Little River near Penrose; Little River at Cedar Mountain; tributary of Allen's creek at Hazelwood; Scott's Creek; and Cedar Creek near Glenville. Collections were made at the above-mentioned stations during June and July of the summers of 1929 and 1930.

Heptagenia spinosa, sp. nov.

A small species, represented by three male imagoes only. The genitalia differ from those of all known North American species, in bearing lateral spines on the penes. Hence the specific name. Thorax reddish brown dorsally. Abdomen whitish, semi-hyaline, last three segments opaque, yellow. Broad purplish dorsal stripe.

Male imago

Size—Body 5–5½ mm.; wing 5½–6 mm.; tails 11 mm.

Head—Pale yellow without distinct marks. Bases of antennae white; filament dusky. Ocelli black-ringed at base.

Thorax—Pale reddish brown dorsally. Pleura and sternum creamy white to pale yellow; without markings. Pronotum purplish brown on median line and at center of posterior margin. Metanotum darker than remainder of thorax. Purplish on posterior margin, and at center a transverse purplish line.

Legs—Pale whitish with faint yellowish tinge. Fore leg more yellowish than others. Fore femur light purple at femoro-tibial joining, and with faint dark stripe on distal inner margin. Other legs with faint darker ring at distal end of femur. First fore tarsal joint between ¼ and ⅓ of second.

Wings—Hyaline. All veins colorless.

Abdomen—Segments 1–7 whitish, semi-hyaline. Segments 8–10 yellow dorsally, creamy white ventrally; opaque. Broad purplish dorsal band on 1–8, leaving lateral margins widely white. Whitish

submedian streaks within this dark band, and mid-dorsal line narrowly white. Posterior margin of each tergite narrowly dark purple, along extent of dark median band. On tergites 1–5, the purple band is lighter posteriorly, and darker from this light area forward to center of tergite.

Tails—White, tinged with yellow at base. Joinings narrowly purplish in basal third; remaining portion unmarked.

Genitalia—Forceps faintly smoky; penes pale yellow. Penes of a different type from any other species of this genus in North America. Forceps long and slender, the two terminal points together as long as the second joint (as in the *lucidipennis* group). Penes united, bearing a pair of stout blunt spines on the median line, and several short spines on each lower lateral margin. (See Figs. 6 and 7.)

Holotype—Male imago. North Fork Swannanoa River, N. C., June 30, 1930. No. 1115.1 in Cornell University collection.

Paratypes—Two male imagoes, same data. No. 1115.3–4 in Cornell collection.

These three males were taken as subimagoes, at the lights of the automobile, about 9.30 p.m. the evening of June 30, on the banks of the North Fork of the Swannanoa River. They transformed into imagoes the following day. Females and nymphs of this species not known.

Genus ECDYONURUS Eaton 1868

I have recently had the opportunity to study nymphs and imagoes of the genotype of Ecdyonurus, *E. venosus* Fab. These specimens were kindly sent to Prof. Needham by Prof. M. E. Mosely of S. Kensington, England. It would seem from these specimens that Ecdyonurus is a valid genus, distinct from true Heptagenia on the one hand and from Stenonema on the other, and one which has not been reported from North America. (Species listed as Ecdyonurus by Dr. McDunnough and others, now fall in the genus Stenonema.)

Nymphs of Ecdyonurus, as described and figured by Eaton (Monograph, Pl. 62, Figs. 1–23) possess an epaulet-like postero-lateral extension of the pronotum. Schoenemund (Zool. Anz. **90**: 45. 1930) uses this character as the basis for separating nymphs of Heptagenia from those of Ecdyonurus. North American nymphs of the genus Stenomena are probably not known to him. In his account of the

mayflies of Germany (Die Tierwelt Deutschlands, 19 Teil, 1930) moreover, Schoenemund includes in the genus Heptagenia the species *gallica*, *coerulans*, and *flava*, nymphs of which (op. cit. 78, figs. 129 and 132) are quite different from any known North American species of Heptagenia. Regarding gill structures, spines on the abdominal segments, and pectination of claws, the specimens of *E. venosus* differ very little from the North American Heptagenia nymphs of the *maculipennis* group. The hypopharynx of *E. venosus* is not quite similar to that of any North American Heptagenine I have studied, but otherwise the mouthparts resemble Heptagenia.

Among my North Carolina specimens are a few nymphs which resemble those of *E. venosus* in the peculiar posterior extension of the pronotum. In all other characters they are so similar to Heptagenia nymphs of the *maculipennis* group as to lead me to think that they belong to that genus rather than to Ecdyonurus. Since, however, none of these nor similar nymphs were reared, the genus cannot be definitely determined. I place them tentatively in the genus Ecdyonurus, because of the structure of the pronotum.

These nymphs were taken from the Toxaway River just above the big falls, on July 16, 1930, and from the Pacolet River at Tryon, July 14, 1930. Nymphs which show a very slight development of the hind angles of the pronotum occurred in the Rocky Broad River at Lecky Gap and in the tributary of the Pigeon River west of Hazelwood in June and July. The following description is based on the specimens from the Pacolet River.

? **Ecdyonurus** sp?

Size—Body 7 mm.; tails broken (on Toxaway River specimen, 10 mm.)

General color—Light reddish brown dorsally, pale ventrally.

Head—Very small white spot anterior to median ocellus and laterad of each lateral ocellus. Narrow white line from outer edge of eye to margin of head. Frontal portion of head very large. A few indistinct brown dots on frons, as in Heptagenia nymphs of the *maculipennis* group. Mouthparts very similar to *H. aphrodite* and *juno*, the outer margin of the mandibles rather more strongly incurved. Five long hairs at base of inner canine, on each mandible.

Thorax—Pronotum widest at middle, its postero-lateral margins extended backwards in a short, rounded projection. Irregular white

marks on anterior margin, near middle of each side. Mesonotum marked irregularly with creamy white. Pale whitish ventrally.

Legs—Coxae and ante-coxal pieces marked with dark brown. Femur brown, its basal and apical ends white. White median transverse bar, another near distal end. Small white spot in central area, between base and median bar. Hind margin fringed with long hairs. Upper surface with many small dark spines. Large brown spot on ventral surface at distal end. Femoral flange prominent. Tibia pale dusky brown in basal two-thirds, pale distally. Hind margin white. Cap-like basal portion adjoining femur, and fore margin, narrowly black. Tarsus and claw brown, unmarked. Claw pectinate.

Abdomen—Postero-lateral spines on segments 3–8, long except on 3. Tergite 1 largely whitish. Tergites 2, 3, 9, and 10 largely brown; 2 and 3 with black marks. Tergites 4–8 creamy white posteriorly, dark brown basally. Three roughly triangular brown areas, with black markings, on anterior margin, projecting backwards into light area; their edges irregular. Tergite 6 wholly brown at center. Tergites 5, 7, and 8 with wide white blotches on each side of narrow dark median line. Ventrally pale creamy white, apical sternites yellow-tinged. Sternites 8 and 9 with brown lateral margins, wider on 9.

Gills—Filaments absent from seventh gill. Gill plate mainly dark purplish grey, light grey on basal portion of outer margin. Only main trachea distinct. Filaments light purplish grey.

Tails—Dusky brown. Basal third of each segment white, distal portion brown. Joinings dark brown, alternately wide and narrow. Circle of spines at each joining, as in Heptagenia. Distally, dark joinings less prominent.

Genus IRON Eaton 1883

Mature nymphs of the Epeorus—Iron group are two-tailed, a character which distinguishes them from all other eastern Heptageninae. I am considering all known species of this group from eastern North America, with the exception of *Epeorus albertae* McD., as belonging to the genus Iron. For a further discussion of this question, I refer the reader to my paper on the subfamily Heptageninae (Journ. N. Y. Ent. Soc.).

Several species of Iron were taken in North Carolina. These may be divided, on structural characters, into two groups. Group I has the following characters. (1) Gills of first pair shorter than others, and broader at base, produced into a short lobe on the anterior margin.

These gills do not approach one another closely beneath the body of the nymph. (2) Head not noticeably wider at front margin than elsewhere, usually widest at or near middle. (3) Outer postero-lateral spines of abdominal segments long and sharp-pointed. Those of the central segments usually as long as or longer than one-half the length of their respective segments, and about three times as long as their own width at base. Inner spines usually about one-half as long as outer ones. (4) Femoral flange of the last two pairs of legs sharp-pointed at apex. (5) Five short teeth or spines near tip of each claw, on inner margin.

Group II is characterized thus. (1) Gills similar to those of Group I. (2) Head definitely widest anterior to middle, usually near the front margin. Hind margin relatively very narrow. Eyes small for size of head. (3) Outer postero-lateral spines usually short and rather blunt. Those of central segments not longer than one-fourth of the length of their respective segments, and about as long as their own width at base. Inner spines about as long as outer ones. (4) Femoral flange of second and third pairs of legs rather short and blunt at apex. (5) Four short teeth or spines on inner margin of each claw, near the tip.

While Group I has the nymphal characters usually assigned to the genus Epeorus, the male imagoes of the one reared species of this group have dissimilar fore claws. (In Epeorus the fore claws of the male are similar and blunt.) Group II, however, does not have the characters usually assigned to Iron, as the gills of the first and last pairs are not greatly enlarged, and do not meet beneath the body of the nymph. The genitalia of the male imagoes are very similar to those of Group I, and the fore claws of the males are dissimilar. Group II is thus intermediate between Epeorus and Iron, as these genera were characterized by Eaton. As stated before, I consider all these forms as members of the genus Iron.

At least four species of Group I and two species of Group II were collected in the state. Of these, complete life histories were obtained for two, both of which proved to be new species. Female imagoes alone were reared from nymphs of a third species. The two new species are described. The unreared nymphs, and the species with incomplete life history, are indictated by number only. The latter may also be new. Very little attempt is made to describe the unreared nymphs, as they are very similar one to another. Aside from the one species listed as No. 1, which was taken at two different places in the piedmont, all were found in the mountain area of the state.

Iron rubidus, sp. nov.

A species of Group I. Very close to *humeralis* Morgan. Gills of nymph distinctly reddish. Wings semi-hyaline, longitudinal veins very faintly brownish. Male whitish. Abdominal tergites with narrow dark posterior borders, black medio-dorsal line, indistinct dark lateral streaks and faint dark stigmatic marks.

	SIZE		
	BODY	WING	TAILS
Male imago	8 – 9	8–9	25
Female imago	9½–11	11	17

Male imago

Head—Pale yellowish. Small brown spot on each side of median carina, between antennae. Brown streak on each side of face, at corner of eye. Posterior margin of vertex brown at center. Base of antennae pale; filament faintly dusky, tip pale. Eyes of living insect bright green.

Thorax—Pale yellowish brown. Lateral and posterior margins of pronotum brown; brown streak on each side of median line, from middle to posterior margin. Mesonotum with four small dark marks between wings. Scutellum orange-brown, posterior margin black, with white lateral areas. Metanotum whitish anteriorly; posterior half orange-brown, purplish laterally. Pleura pale. Several purplish black marks on coxae and above each leg. Ventrally pale yellowish.

Legs—First joint of fore tarsus very slightly shorter than second joint. Legs pale yellowish. Each femur yellow, with usual prominent dark median band, and narrowly dark at apex. Fore femur slightly dusky. Tip of fore tibia purplish. Claws of all legs dissimilar.

Wings—White, semi-hyaline. Longitudinal veins very faintly yellowish brown. Humeral cross vein black in half next to subcosta. Stigmatic area opaque white.

Abdomen—Segments 1–7 white, semi-hyaline. 8–10 yellowish brown, paler ventrally; opaque. Each tergite with narrow purplish black posterior margin, faint at center. Medio-dorsal line purplish black in posterior half of tergites 3–9. On 1 and 2, a black median dot only. Purplish mark in stigmatic area of each tergite, and traces of dark

lateral marks on each side. Sternite 1 opaque, pale yellowish. Venter pale, unmarked.

Tails—White, unmarked.

Genitalia—White. Very similar to *humeralis* Morgan, but short lateral projections on penes less prominent. Second joint of forceps slightly longer, relatively, than in *humeralis*. See Fig. 9.

Female imago

Very similar to male. Abdomen rose to salmon-red, due to color of eggs. Lateral and stigmatic marks very faint, also posterior margins less well-marked than in male. Cross veins of stigmatic area of fore wing light brown. In living insect, eyes are bright green. Fore part of head and pronotum deep orange. Pleura marked with orange.

Nymph

Very similar to that of *humeralis*, but differs from it in (1) the reddish color of the gills; (2) whole body definitely reddish to yellowish brown (in *humeralis*, greenish brown); (3) legs barred with reddish brown (in *humeralis*, with greyish brown); and (4) branches of tracheae in gills much less numerous, also less prominent, being dull purplish instead of black in color. Abdomen dorsally yellowish brown. Each tergite with a black median line, and two dark brown subdorsal spots surrounded by light areas. The light areas especially prominent on 6. Ventrally white, as opposed to the distinct yellow ventral surface of *humeralis*. The latter has also purplish transverse markings on the venter of the thorax, which are not present in *rubidus*. Outer canines of mandibles rather longer and more slender than in *humeralis*.

Holotype—Male imago, reared. Flat Creek at Black Mountain, N. C., June 16, 1929. No. 1116.1 in Cornell collection.

Allotype—Female imago, reared. Same location, June 15. No. 1116.2 in Cornell collection.

Paratypes—5 male imagoes, 11 female imagoes. Flat Creek, June 15–19, 1929, and June 29, 1930; Ocona Lufty River, June 22, 1930; Pacolet River at Tryon, July 14, 1930; and Hazelwood July 20, 1930. Nos. 1116.3–18 in Cornell collection.

Imagoes of *humeralis* Morgan have definite orange or brown markings on the venter of the thorax, usually paler in the female. The abdominal tergites, while showing a considerable variation in color, usually have a

rather wide brown band on the posterior margin, widest laterally. The fore femora of the male imago have a distinctly orange or reddish apical band; the foretarsal joinings are black, the tip of the tibia widely black. Mesonotum paler than in *rubidus*. Wings more transparent, veins almost invisible. Eyes of male much larger than in *rubidus*.

This species was found only in the mountain area of the state. Other locations from which it was collected during June and July of 1929 and 1930 are listed below. Swannanoa River; North Fork of Swannanoa River; Rocky Broad River at Lecky Gap; Wayah Creek, near Franklin; Spring Creek, near Hot Springs; and the Pigeon River near Woodrow. Two males, one from Calatoochee Creek, and the other from Allen's Creek near Hazelwood, are probably of the same species but are not included among the paratypes.

Three other species of nymphs of Group I were taken in the state. These I designate as Iron sp. Nos. 1, 2, and 3.

Iron sp. No. 1

The only species of Iron found in the piedmont. Collected from the stream at Cascades, another stream near Danbury, and from a small tributary of the Uharie River. Almost mature nymphs were found by the middle of May. Female nymph 12 mm. in length; male 9 mm. Light reddish brown dorsally when mature. Markings very similar to the nymph of *rubidus*. Gills grey, very faintly tinged with lavender. Tracheae not distinct. White ventrally, the apical abdominal segments faintly washed with yellow.

Iron sp. No. 2

Another species from the mountain region. Taken at Cedar Creek, near Glenville, in late June and early July. Female nymph 12 mm. in length; male, 10 mm. The four large white blotches on the frontal margin very prominent. Rather dark reddish brown when mature. A wide dark brown mid-dorsal band is present on tergites 3–5 and 7–8. Black median line and dark brown subdorsal markings, as in previous species. Gills light grey, sometimes with purplish tinge. Tracheae not distinct. Bands on femora not as distinct as in *rubidus*. White ventrally, apical abdominal segments yellowish. One nymph shows traces of brown longitudinal marks parallel to lateral margin. In this species, the outer postero-lateral spines are considerably shorter than in others of Group I, but still noticeably longer and more pointed than those of Group II.

Iron sp. No. 3

Taken from a tributary of the Pigeon River at Waynesville, in late July. Seems distinct from *rubidus*, but has very similar markings. Female nymph 12 mm. in length, male 10 mm. Gills light purplish in color; tracheae dull purple, about as distinct as in *rubidus*. Ventrally pale; apical segments faintly yellow.

Iron dispar, sp. nov.

A representative of Group II. Nymph chestnut brown dorsally, yellowish ventrally. Wing veins of imagoes distinctly brown in apical half. Abdomen of male pale, semi-hyaline. Thorax yellowish brown. Purplish brown markings. Fore tibia dark brown washed with purple.

	SIZE		
	BODY	WING	TAILS
Male imago	9	9	23
Female imago	11–11½	11–12½	23–29

Male imago

Head—Pale yellowish brown. Margin of clypeus, edge of median carina, and streak at inner corner of eye, purple. Small purplish dots between antennae, and below base of each. Vertex with purple spot at center of posterior margin. Eyes about same size as *rubidus*. Base of antenna pale; filaments dusky, tips pale.

Thorax—Yellowish brown. Pronotum purple on anterior margin and at center of posterior margin. Purple subdorsal line on each side. Mesonotum with somewhat darker median band, bordered by pale yellow. Mesonotal spine dark brown. Metanotum dark brown, somewhat paler laterally. Pleura yellowish. Purple streak on anterior coxa and antecoxal pieces. Purple marks on other coxae, also before and behind each coxa. Venter pale yellow; mesosternum pale brown.

Legs—Fore femur yellowish brown. Usual purple median spot; apical marking pale. Tibia purplish brown, darker apically. Tarsus pale yellow, joinings widely purplish. Last tarsal segment dusky. Other legs pale yellowish white, with purplish femoral spot, and very narrowly darker at apex of tibiae and at tarsal joinings. Claws of all legs dissimilar.

Wings—Veins and cross veins in apical half of fore wing light brown; those of basal half almost colorless. In hind wing, apical subcostal cross veins and a few intercalaries on outer margin very light brown, other veins colorless. Stigmatic area of fore wing opaque white. Humeral cross vein purplish black in half next to subcosta.

Abdomen—Segments 2–7 yellowish white, semi-hyaline. Tergite 1, and segments 8–10 yellow, opaque. Posterior margin of each tergite purplish, widest at center. Purplish black mid-dorsal line on posterior half of tergites 1–9. Lateral purplish streak on each, between median line and lateral margin. Purple mark at stigma. Lateral markings on tergites 1 and 2 more extensive than elsewhere. Ventrally unmarked, except for two short purple transverse bars on each side of median line on anterior margin of sternite 2.

Tails—Dusky; faintly tinged with yellow. Unmarked.

Genitalia—Penes quite similar to *humeralis* and *rubidus*, but completely lacking lateral projections. In this respect, similar to *punctatus* McD. Apical margin of subanal plate of a different type from any North American species thus far figured. See Figs. 10 and 13.

The male paratype lacks the lateral purple streaks on the tergites, and the tranverse marks on sternite 2, and is also paler than the holotype, from which the description is drawn.

Female imago

Quite similar to male. All veins distinctly dark brown. Humeral cross vein dark purple its entire length. Abdomen orange, paler ventrally. Stigmatic marks often very faint. Posterior margins of tergites as in male, but on tergites 1 and 2 supplemented by another purplish red band just anterior to the margin. Apical extension of sternite 7 pale brown, margined with purplish. Some of the paratypes are much paler on head, thorax, legs, and tails, and lack the brown mark on sternite 7.

Nymph

Chestnut brown dorsally, pale yellow ventrally.

Head—White median streak runs forward from median ocellus. Frontal margin pale, no darker markings.

Legs—Femoral markings consist of the usual purplish black median spot, and four brown longitudinal streaks, two in basal and two in apical portions. Tibiae wholly pale, except for narrow blackish distal mark. Tarsi pale brown basally; purplish in apical third.

Abdomen—Lateral margins widely white. Posterior margins of tergites narrowly dark. Dark mid-dorsal line, and brown sub-dorsal spots. Pale areas surround subdorsal spots only on tergite 6. Tergites 9 and 10 pale yellowish, darker only beside median line.

Gills—Light grey, frequently tinged with purple. Tracheae indistinct.

Holotype—Male imago. Allen's Creek, near Hazelwood, N. C., July 24, 1929. No. 1117.1 in Cornell collection.

Allotype—Female imago. Tributary of Pigeon River west of Hazelwood, N. C., July 25, 1929. No. 1117.2 in Cornell collection.

Paratypes—One male imago, eight female imagoes; reared. Allen's Creek, July 24, 1929; small stream on Cowee Mountain, July 4–10, 1929, and July 28, 1930; Waynesville, July 16–20, 1929; and Scott's Creek near Balsam, July 23, 1929. No. 1117.3–11.

This species was also collected in the Pigeon River near Woodrow, and in a tributary of the Swannanoa River flowing through the Blue Ridge assembly grounds. Two males, not included in the paratypes because the wing veins are almost wholly pale, have very similar genitalia. These specimens were taken at Waynesville and Penrose, N. C., in July.

Iron sp. No. 4

Another representative of Group II. Collected by Professor Needham from Forney's Creek, Great Smoky National Park, August 26, 1931. Nymph more slender and darker in color than *dispar*. General color dark reddish brown. Body of female, 10–12 mm.; tails 14 mm. Male, 8–8½ mm. in length. Pale median streak anterior to median ocellus. Legs with usual median purple spot on femora. Mainly dark smoky brown in color; light areas limited to base, apex, and lateral streak on femur, and apex of tibia. Thorax pale ventrally; two purple transverse bars on anterior and posterior margins of mesosternum. Abdomen dark reddish brown dorsally. Each tergite has the posterior margin blackish; black mid-dorsal streak and dark brown subdorsal spots. These spots, on 6, surrounded by lighter area. Tergite 9 pale in posterior half. Ten has a pale mark on each side of median line. All tergites tend to become darker laterally, but leaving lateral extensions light. Ventrally pale; in female, usually flushed with pink. Posterior margins often very narrowly dark. One specimen has faint brown lat-

eral blotches. Gills olive-brown with distinct purple tinge. Tracheae quite numerous; very dark purple.

Genus RHITHROGENA Eaton 1881

Six species of this genus are represented in my North Carolina material. Of these, one was found in the piedmont, at one location only; the other five occurred in the mountain area. As far as I am able to determine, all of these are new species. The size alone would seem to indicate this. All six are relatively small species, smaller than *impersonata* McD. and barely as large as *anomala* McD. and *jejuna* Etn. There remains the possibility that one of the North Carolina species may be *jejuna* Etn. Two of these forms I designate by number, as they are represented only by nymphs.

Although nymphs of four of the North Carolina species were fairly abundant, it was very difficult, in some cases impossible, to rear them. Careful comparative study of these nymphs shows a remarkable structural similarity in all six species. Color differences are practically the only means of distinguishing one from another. In life, these color differences are much more striking than in alcoholic specimens. Unfortunately, my field notes on the color of the living nymphs are too brief to be of much value.

Structural characters of the nymphs of this genus have been discussed in my paper on the Heptageninae of North America. I might add that, in all the seven species studied, three teeth are found on the inner margin of the claw near the tip, and one larger tooth or spine near the base. Postero-lateral angles of the abdominal segments are not prolonged into spines. The posterior margin of the pronotum is more or less emarginate, sometimes quite deeply cut. Irregular scroll-like markings are present on each side of the pronotum, and usually on the mesonotum as well.

In the following key, I have endeavored to distinguish these six species, by color alone, in the nymphal stage. No attempt is made to distinguish the imagoes, as too few are known fully in that stage.

Key to Rhithrogena nymphs—N. C. species

1. Tergites 1–8 pale yellow, unmarked.....sp. No. 1
   Tergites 1–8 not entirely pale, usually central and apical ones darker.....2
2. Tergites 7–9 yellow, contrasting sharply with central and apical dark tergites..3
   Tergites 7–9 not differing markedly in color from central tergites although usually somewhat lighter.....4

3. Tergites 1–6, and basal half of 7, dark reddish brown. Middle portion of head dark brown ..... *fuscifrons*
   Tergites 1 and 2 pale yellow, 3–6 dark reddish brown, 7 wholly pale. Middle of head yellow, or shaded with very light brown ..... *exilis*
4. Dorsum of abdomen light chestnut or cinnamon brown ..... *uhari*
   Dorsum of abdomen orange or orange brown 5
5. Tergites 4–8 dark brown basally, with pale posterior margins, thus appearing to be banded ..... *fasciata*
   Tergites of 4–7 entirely dark brown; 8 and 9 yellowish brown, with yellow subdorsal marks. Do not appear to be banded ..... sp. No. 2

From the piedmont area

Rhithrogena uhari, sp. nov.

This species was found only in the piedmont, in Caraway Creek. This stream, which is a tributary of the Uharie River, flows through the Uharie Mountains. Collections were made not far from the small town of Sophia, in April and May of 1929 and 1930.

Nymph

Size—Body of male nymph, 5–6 mm.; of female 6–7 mm. Tails 4 mm.

General color—In life, light chestnut to cinnamon brown dorsally, without conspicuous markings. Gills forming a prominent grey fringe around the abdomen.

Head—Ocelli black-ringed, eyes black. A light area near each ocellus. Antennae yellowish. Indistinct light transverse bar near center of vertex. Seven pectinate spines on crown of maxilla.

Thorax—Indistinct brownish scroll-like markings on pronotum, and a more or less distinct dark transverse band near center. Very faint markings on mesonotum. Anterior margin of mesonotum, and a small spot at each side of median line, dark brown. Ventrally pale whitish.

Legs—Pale yellowish white. Femora faintly washed with brown; usually not banded nor barred. Very faint round purplish spot near center of each femur, and numerous small brown spines on upper surface. Tarsus yellowish brown at each end. All joinings dark brown.

Abdomen—Each tergite very narrowly brown on both anterior and posterior margins. In general, uniformly chestnut brown in color. Faint traces of an oblique light mark on each side of median line at anterior margin, and of a small light spot on each side of median line near center of tergite. Tergite 10 often slightly darker than others.

(One specimen has tergites 8 and 9 yellowish.) Ventrally, pale yellowish white.

Gills—Light grey. Filaments same color.

Tails—Pale yellow.

Female imago

Size—Body 6 mm.; forewing 7 mm.; tails 8 mm.

General color—Pale yellowish; the anterior abdominal tergites banded with purplish.

Head—Black mark below each antenna. Base of antenna white. Basal portion of filament dark, remainder light brown. Faint brownish markings above frontal margin.

Thorax—Pronotum and mesonotum pale yellowish. Small dark spot near center of lateral margin of pronotum. Faint purplish shadings near wing roots, on mesonotum. Brown shading on each side of mesonotal spine. Metanotum yellowish brown, darker posteriorly. Pleura paler than notum. Purplish marks below each wing root, and faint dark lines above middle and hind legs. Ventrally pale, the mesosternum washed with yellow.

Legs—Pale whitish. Small round black spot at center of each femur. Tarsi somewhat smoky, with black spot dorsally at each joining. Claws black at base and tip, and narrowly along upper margin.

Wings—Semi-hyaline, whitish (tending to look distinctly milky). Pterostigmatic area with milky cloud. All veins white.

Abdomen—Dorsally light yellowish brown. Tergites 1–5 with purplish posterior margins. Tergites 6–10 more washed with yellow, not banded. Pleural fold whitish. Ventrally pale yellow, unmarked. Apical extension of 9th sternite very slightly emarginate at center.

Tails—Pale yellow, unmarked. Joinings opaque.

Holotype—Female imago, reared. Caraway Creek, the Uharie Mountains, N. C., May 13, 1929. No. 1118.1 in Cornell collection.

Paratypes—Female subimago, reared. Same data. 20 nymphs, same location, April 20, 1929. No. 1118.3–23 in Cornell collection.

Nymphs that seem similar to those from Caraway Creek were collected near Hillsville, Va., on May 4, 1929. No others were found at any other station in North Carolina.

From the mountain region

Rhithrogena exilis, sp. nov.

Nymph

Size—Body of male nymph, 4½–5 mm.; of female, 5–6 mm. Tails 4 mm.

General color—Pale yellow with dark brown markings and bands.

Head—Frontal and lateral margins pale whitish. Central area between eyes yellow. In a few specimens, head shaded with light brown. Antennae very pale yellow. Lateral ocelli long, roughly comma-shaped. Nine pectinate spines on crown of maxilla.

Thorax—Pronotum deeply emarginate on posterior margin. Dark brown, with few scroll-like yellow markings. Meso- and metanota, and wing cases, yellow. Faint brown marks on each side of median line, on anterior margin of mesonotum. Few faint irregular brown marks anterior to wing roots, and at joinings of wing-cases to one another. Ventrally pale yellowish white.

Legs—Pale yellowish white, marked with dark brown. Each femur has customary dark median spot, and two wide dark brown transverse bands, one near each end. Spines on upper surface also dark brown. Tibia and tarsus rather smoky, the tarsus somewhat darker. Basal end of tibia dark.

Abdomen—Tergites 1 and 2 pale yellow, unmarked. Tergites 3–6 dark reddish brown, unmarked; lateral extensions yellow. Tergites 7–9 yellow, unmarked. Tergite 10 brown in apical half. Ventrally, sternites 1 and 2 pale; 3–6 light brown; 7–9 pale, the latter tinged with yellowish brown apically. Some nymphs have brown marks at anterior margins of central segments, and posterior margins narrowly dark.

Gills—White or very pale grey. Filaments light purplish grey.

Tails—Pale yellow. Narrowly light brown at joinings.

Female imago

Size—Body 6 mm.; forewing 7 mm.; tails broken.

General color—Body yellow. Abdomen tinged with pink.

Head—Black half-ring at base of each antenna. Black spot on each side, underneath clypeus.

Thorax—Purplish black irregular mark laterally on pronotum. Faint darker markings on pleura. Ventrally unmarked.

Legs—Purplish black median mark on each femur. No other markings.

Wings—Semi-hyaline. Cross veins of stigmatic area show some anastomosis, as is usual. Veins colorless.

Abdomen—Posterior margins of tergites 2–4 narrowly dull purple. Segments 2–6 flushed with ink or orange. Venter pale, unmarked.

Tails—White, unmarked.

Male subimago

General color—Orange-brown.

Head—Marked as in female.

Thorax—Dark brown comma-shaped mark on each side of mesonotum, just anterior to spine. Brown lines run forward from these marks. Pleura with dark marks above each leg. Mesosternum margined with dark brown.

Legs—Dark mark on each coxa, and at each joining of foreleg, as well as median femoral mark.

Abdomen—Dark orange-brown, the posterior half of each tergite somewhat darker.

Wings and *tails* dark smoky brown. Genitalia not sufficiently developed to be certain of their form.

Holotype—Female nymph. North Fork of Swannanoa River, N. C., June 14, 1929. No. 1119.1 in Cornell collection.

Paratypes—Female imago, reared. Flat Creek, at Black Mountain, N. C., June 13, 1930; 3 female subimagoes, reared, same location June 22–24, 1930; male subimago, reared, same location, June 20, 1929; 20 nymphs, same location, June 17, 1930. Nos. 1119.3–27 in Cornell collection.

A nymph which seems similar to those taken at the above stations was found in the Cullasaja River near Franklin, N. C., on July 3, 1929.

Rhithrogena fuscifrons, sp. nov.

Nymph

Size—Body 5–5½ mm.; tails 6 mm.

General color—Very similar to preceding species. Reddish brown patch in center of head.

Head—Dark reddish brown in central portion, from ocelli to front margin, and on vertex. Lighter brown between vertex and ocelli. Lateral areas, anterior to compound eyes, pale yellowish white. Lateral ocelli V-shaped; the arms of the V black, the space between them dark grey. Antennae pale. 8–9 pectinate spines on crown of maxilla.

Thorax—Dorsally yellowish brown with dark brown markings on each side of pronotum, between wing bases and anterior to wing roots. Pronotum deeply emarginate on posterior border. Wing buds orange brown. Ventrally pale yellowish white. In some nymphs, the general dorsal color is somewhat darker brown.

Legs—Pale yellowish. Coxae brown. Femora with usual purplish median spot, rather small. Fore margin of femur brown, and brown band near apical end. More or less shaded with brown in basal half and sometimes along hind margin. Spines brown, not present on apical half. Tibia pale. Tarsus pale smoky.

Abdomen—Segments 1–6, and basal half of 7, dark reddish brown; paler ventrally. Apical half of 7, and 8–10, yellow. In some specimens, apical half of 10 tinged with light brown. Lateral extension orange-brown.

Gills—White. Filaments light purplish grey.

Tails—Yellowish, narrowly dark brown at joinings.

Female imago

Size—Body 5 mm.; forewing 7½ mm.; tails 8 mm.

General color—Light orange-brown.

Head—Small black spot at base of each antenna. Posterior margin of head brown. Antennae dark brown basally, the tips lighter.

Thorax—Posterior margin of pronotum, and its lateral areas, tinged with purplish. Spines of meso- and metanota, and lateral margins of these spines, tinged with purplish. Pleura paler with a few purplish marks, and a dark streak above the fore and middle legs. Pale ventrally, the posterior portion of the mesosternum as dark as the notum.

Legs—Yellowish, the tibiae and tarsi somewhat smoky. Usual dark purple mark near center of each femur. All joinings dark brown.

Wings—Semi-hyaline. Veins pale yellow, cross veins faint.

Abdomen—Tinged with purplish brown dorsally, darker on tergites 2–6. Posterior margin of tergites very narrowly dark purplish. Pale ventrally.

Tails—Pale whitish. Joinings very narrowly dark.

Holotype—Female nymph. Tributary of Pigeon River, four miles west of Hazelwood, N. C., July 21, 1930. No. 1120.1 in Cornell collection.

Paratypes—Eight nymphs. Same data as holotype; Rocky Broad River at Bat Cave, N. C.; tributary of the Ocona Lufty River, July 12, 1929; tributary of the Cullasaja River near Franklin, N. C., June 24, 1929. No. 1120.3–10.

Immature nymphs were also taken from the Ocona Lufty River on June 22, 1930, and from the Cullasaja River on July 3, 1929.

I had at first taken this species to be identical with the preceding one. But the quite constant color differences, as well as the difference in the time of maturing, lead me to believe that this species is distinct.

Rhithrogena fasciata, sp. nov.

Nymph

Size—Body 5½–7 mm.; tails 5-7 mm.

General color—Orange, marked with dark brown. In life, appears orange and black.

Head—Dark orange-brown, laterally somewhat lighter orange. Four small white spots on vertex, much as in sp. No. 2. Antennae light brown, 10 pectinate spines on crown of maxilla.

Thorax—Pronotum very deeply emarginate on posterior margin. Pronotum shaded with orange. Remainder of notum rather smoky brown. Irregular lighter marks, also darker brown ones, on pro- and mesonota. Ventrally, pale yellowish. Narrow black transverse bar on mesosternum.

Legs—Pale yellowish white. Femora marked with light brown; darker at apex. Tibiae whitish. Tarsi slightly smoky.

Abdomen—Reddish brown marked with yellow. Lateral extensions dark brown. Large yellow area next to dark margin, bounded on inner side by another dark streak. Triangular brown lateral areas on each tergite, extending inward to median line on tergites 1–3. Tergites 4 and 7 dark brown in basal two-thirds, yellow apically. Tergites 5 and 6 all brown except narrow yellow dorsal line and narrow posterior margin. Anterior tergites thus appear to be banded, 8 and 9 yellow except for narrow dark band on anterior margin; 10 dark brown, with narrow yellow anterior margin. Ventrally, light yellowish brown. Each sternite narrowly dark brown on posterior margin. Traces of lateral and oblique subventral lighter streaks on each sternite.

Gills and filaments silver-white.

Tails—Yellowish white. Joinings narrowly dark brown.

Male imago

Size—Body 6 mm.; forewing 6 mm.; tails 10 mm.

General color—Pale yellowish.

Head—Pale yellow. Edge of clypeus colorless, transparent. Small

black spot at base of antenna. Small black spot beneath clypeus on each side. Purplish area around base of antenna. Base of antenna white. Filament smoky, tip white.

Thorax—Pronotum deeply emarginate posteriorly. Yellowish orange in color. Mesonotum pale yellow. Brown area on each side of mesonotal spine. Metanotum brown. Pleura pale with ochreous markings. Venter pale ochreous, the posterior half of the mesosternum distinctly tinged with brown.

Legs—Yellowish brown, femora deeper brown. Round purplish spot at center of each femur; not elongate (thus resembling *anomala* McD.). All joinings narrowly dark purplish.

Wings—Semi-hyaline. Longitudinal veins yellowish to yellowish brown; cross veins colorless. Cross veins in stigmatic area show some anastomosis.

Abdomen—Pale smoky, with ochreous tinge on some segments. Segments 1 and 2 pale, very faintly smoky. Segments 3–6 deeper smoky, with definite lavender tinge. Posterior margins of all tergites dull pale lavender, thus giving a banded appearance. Indistinct lighter subdorsal dashes and a light median line on tergites 2–7. Segments 7–10 tinged with pale ochreous. Paler ventrally. Ganglionic area colorless; banding not apparent.

Genitalia—Pale brown in color. In form, quite close to *anomala* McD., but differing in minor details. See Fig. 5.

Tails—Whitish; unmarked.

Holotype—Male imago. Waynesville, N. C., July 17, 1929. No. 1121.1 in Cornell collection.

Paratypes—Four male subimagoes, reared. Same location, July 16, 1929; and 12 nymphs, same data. No. 1121.3–18.

This species was found also at Flat Creek near Black Mountain; in the Cullasaja River; in Bald Creek, west of Burnsville; and in a tributary of the Rocky Broad River near Bat Cave.

Rhithrogena sp. No. 1

Nymph

Size—Body 5 mm.; tails 4 mm. (immature nymph).

General color—Pale yellow with dorsum of thorax and tergites 9 and 10 dark brown.

Head—Pale, except posterior margin of vertex and posterior portion of lateral margins, which are brown. Ocelli as in *fuscifrons*. Antennae pale. 7–8 pectinate spines on crown of maxilla.

Thorax—Brown dorsally, unmarked. Ventrally pale greyish. Pronotum very slightly emarginate on posterior border; much less deeply cut than in *exilis* or *fuscifrons*.

Legs—Pale. Usual small purplish spot on femora I and II; absent or very indistinct on femur III. Femora faintly brown apically. Narrow black line near basal end of tibia. Small brown spines present on basal half of femur.

Abdomen—Segments 1–8 pale yellow; 9 and 10 dark brown.

Gills—White. Filaments very pale grey.

Tails—White. Joinings very narrowly yellowish brown.

I have only nymphs of this species, and these not yet fully mature. It is much less common than any of the preceding species. Nymphs were found in the Ocona Lufty River on July 12, 1929; in a tributary of the Davidson River, July 9, 1929; and in the Laurel River near Hot Springs on June 29, 1930. In each case, only one or two nymphs were seen.

Rhithrogena sp. No. 2

Nymph

Size—Body 7 mm.; tails broken.

General color—In life, bright orange dorsally. Alcoholic specimens orange-brown.

Head—Dark orange-brown. Four small white spots on vertex, two on each side of center. Anterior pair wider apart than others. White line from corner of compound eye to outer margin of head. Antennae light brown.

Thorax—Pronotum rather deeply emarginate on posterior margin. Orange-brown dorsally. Few scroll-like brown markings on pronotum, and on mesonotum between wing buds. Dark brown transverse band across center of pronotum. Anterior margin of mesonotum dark brown, also dark brown at wing joinings. Ventrally pale.

Legs—Femora brown, with prominent white longitudinal streak, near apical end of which is the usual purplish spot. Brown spines present in basal half. Apical end of each femur darker brown. Tibiae much paler, rather smoky brown, with narrow dark band near basal end. Tarsi and claws similar in color to femora.

Abdomen—Orange brown dorsally, the lateral extensions paler brown. Tergites 4–7, and 10 except at base near median line, darker brown than others. Tergites 8 and 9 yellowish brown, each with two yellow subdorsal streaks. Faint indications of these streaks occur on 4–7. Ventrally pale brown, sternite 9 darker. Posterior margins of sternites narrowly dark brown. Traces of pale lateral lines and oblique subventral dashes.

Gills—Greyish, with faint lavender tinge at base. Filaments purplish grey.

Tails—Yellowish brown, joinings narrowly dark brown.

Nymphs of this species were taken from the Rocky Broad River at Lecky Gap on June 23, 1930. A quite similar nymph, probably of the same species, was found in the Laurel River on June 29, 1930. No adults of this species were obtained. The species is not common, only a few nymphs being found in each location named.

Genus STENONEMA,* gen. nov.

Of all the Heptagenine mayflies of the state, the members of this genus were by far the most common. In numbers of species found, it also exceeds all others in this group. Representatives of the genus were taken in each of the three regions of the state, and many species were reared from the nymphs. My collection from North Carolina includes 16 species, distributed as follows: from the coastal plain, 2 species; from the piedmont, 9 species; and from the mountains, 9 species.

As stated in my paper on the Heptageninae of North America, the species of this group appear to fall into three distinct groups. These groups I have termed the *interpunctatum* group, the *vicarium* group, and the *tripunctatum* group. At the time of writing the above-mentioned Heptageninae paper, the nymph of *carolina* was not known to me. Recently I have reared this species from nymphs taken in the vicinity of Ithaca, N. Y. This nymph is so similar in structural details to those of the *interpunctatum* group that I do not now consider this species as

* The word Stenonema is neuter gender. It has reference to the thread-like character of the 7th gill of the nymph. The genus includes those North American species formerly placed in Ecdyonurus.

In the male imago, the first fore tarsal joint is ½ to ⅔ the length of the second. Genitalia somewhat resemble those of species of the European genus Ecdyonurus. Cross veins of the stigmatic area of the fore wing are not anastomosed, thus differing from Ecdyonurus. The seventh gill of the nymph is a slender tapered thread or filament.

I designate *tripunctatum* Bks. as the type of the genus.

representing a fourth group within the genus, a possibility I had suggested because of the genitalic differences of the male.

There are, however, good grounds for the belief that the *interpunctatum* group is quite widely remote from the other two groups, which are rather closely related. When Eaton figured the nymphs of this genus in the Revisional Monograph, he placed the nymph of the *interpunctatum* group (Pl. 57) in a separate genus from the nymph of the *vicarium* group (Pl. 58). It is quite possible that further study of this difficult but interesting genus will show that the *interpunctatum* group is indeed worthy of generic rank apart from the *vicarium-tripunctatum* groups. For the present, I leave all these three groups in the one genus.

The *interpunctatum* group may be subdivided into (1) species related to *interpunctatum* and *frontalis*, and (2) into species allied to *carolina*. The *vicarium* group, likewise, may be subdivided into (1) those species resembling *vicarium* and *pudicum*, and (2) those related to *pulchellum*, *terminatum*, and *integer*. If I am correct in the belief that *luteum* Clem. is a member of the *tripunctatum* group, that group will also show two divisions: (1) the species allied to *tripunctatum*, and (2) those allied to *luteum*.

The characters of these groups and their subdivisions may be summarized as follows:

I. *Tripunctatum* group (*tripunctatum* Bks., *femoratum* Say, probably also *luteum* Clem. and perhaps *medio-punctatum* McD.).

Nymphs—Claws with two pectinations. Gill of 7th pair with trachea present, its outer margin hairy. Gills 1–6 rounded at tip. Spines on abdominal segments 5 and 6 about equal in length to that on 7. Spine on segment 9 equal to or longer than that on 7.

Imagoes—Genitalia of the *tripunctatum* type (see Fig. 14). Many cross veins of the fore wing often heavily infuscated, especially at and below the bulla. At bulla, cross veins of costal, subcostal, and radial spaces closely crowded together, some often rather oblique. Hind wing dark-bordered, in first two species. In male foretarsus, 1st joint equals 5th, 1st is one-half or more of 2nd, 3rd slightly longer than 2nd, 4th equals 2nd.

II. *Vicarium* group.

A. *Vicarium* division (*vicarium* Wlk., *pudicum* Hagen, *fuscum* Clem., *ithaca* Clem. and Leon.).

Nymphs—Claws without pectinations. No trachea in gill of 7th pair, its margin very hairy. Gills 1–6 oblong or truncate at tip. Spines on abdominal segments 5 and 6, if present, very short—always shorter than that on 7. Spine 9 variable in length in relation to that on 7.

Imagoes—Genitalia of the *pudicum* or *vicarium* type (see Fig. 12). Few to many cross veins in fore wing infuscated, usually most at and below bulla. Cross veins of first three or more spaces crowded together at bulla. Hind wing may be dark-bordered. Venter of abdomen may be marked. In male foretarsus, 1st joint equals 5th, 1st equals ½ of 2nd, 3rd equals 2nd, 4th about ⅔ of 3rd.

B. *Pulchellum* division (*pulchellum* Wlsh., *ruber* McD., *bipunctatum* McD., *terminatum* Wlsh., *placitum* Bks., *rubromaculatum* Clem., *varium* n. sp., *annexum* n. sp., *exiguum* n. sp., *bellum* n. sp., and perhaps *subaequalis* Bks.

Nymphs—Claws with two pectinations. Spine of segment 9 equal to, or shorter than, that on 7. Otherwise similar to nymphs of *vicarium* group.

Imagoes—Genitalia of *pulchellum* or *terminatum* type (see Figs. 16 and 4). Only a few veins, or none, in fore wing, infuscated, not noticeably more so at bulla than elsewhere. No crowding of cross veins at bulla. Foretarsus of male similar to that of *vicarium* group, except that 1st joint may be ⅓ to ½ of 2nd, or more than ½ of 2nd, and 4th may be ¾ of 3rd. In *integer* and *exiguum*, hind wing is narrowly dark-bordered. Genitalia of *pulchellum*, *ruber*, *annexum*, *varium*, and *rubromaculatum* are of the *pulchellum* type; other species have genitalia of the *terminatum* type.

III. *Interpunctatum* group.

A. *Interpunctatum* division (*interpunctatum* Say, *canadensis* Wlk., *frontalis* Bks., *affine* n. sp., *pallidum* n. sp.)

Nymphs—Claws without pectinations. Trachea present in gill of 7th pair, apparently not forked. Fine hairs on margin of 7th gill. Gills 1–6 pointed at tip. No spines on abdominal segments 1–6. Spine on segment 9 longer than that on 7 which is very short.

Imagoes—Genitalia of the *interpunctatum* type (see Fig. 3). Several cross veins in basal portion of costal, subcostal and radial spaces thickened at center, or in costal space, near costal margin. At bulla, these margined cross veins fully or almost connected by black transverse dash.

Intercalaries in 3rd or 4th space at apical margin may be thickened. Hind wing always dark on outer margin, marginal intercalaries usually black. In male foretarsus, 1st joint equal to or longer than 5th; 1st joint $\frac{1}{3}$, $\frac{1}{2}$ or more than $\frac{1}{2}$ of 2nd; 2nd and 3rd about equal; 4th a little more than $\frac{1}{2}$ of 3rd.

B. *Carolina division* (*carolina* Bks.)

Nymphs—Trachea in 7th gill forked at base, thus giving appearance of two longitudinal tracheae. Otherwise similar to nymphs of preceding group.

Imagoes—Genitalia of the *carolina* type (see Fig. 2). No black transverse bar connecting margined cross veins at bulla. A few basal cross veins of costal and radial spaces thickened, those in costal space always thicker at costal margin. In male foretarsus, 1st joint somewhat longer than 5th; 1st equals $\frac{1}{2}$ of 2nd; 4th a little more than $\frac{1}{2}$ of 3rd and about equal to 1st.

Subaequalis Bks. is known to me only by the published description. I am unable to find among my North Carolina material any specimen which meets all the specifications for this species. Because of points mentioned in the original description, the species would seem to be of the *pulchellum* group, although differing from others of that group in the relative lengths of the joints of the male foretarsus.

Specimens in the Cornell University collection which seem to fit descriptions of *luteum* Clem., *mediopunctatum* McD., and *rubromaculatum* Clem. indicate that the first two species are members of the *tripunctatum* group, while the third species is of the *pulchellum* division. Since, however, I have not seen type material of any of these three species, my tentative identifications may be in error.

Key to male imagoes, genus Stenomena—North Carolina species

1. Cross veins in costal and radial spaces, before and at bulla, thickened at center (or in costal space near costal margin) by black marginings.....2
   Cross veins in these spaces, if margined, are thickened equally along entire length.....6
2. Radial cross veins at bulla connected along center line by a continuous black streak; spinous processes present on outer lateral margins of penes.....3
   Black marginings along center of radial cross veins at bulla very thick and prominent, but not connected to form a continuous line; no spinous processes on outer lateral margins of penes.....*carolina*
3. Prominent black longitudinal streak on each side of pronotum.....4
   No such black lateral streak on pronotum.....*affine*

4. Black mark of dash present under antenna.....5
   No dark mark under antenna.....sp. No. 2
5. Median band present on hind femur—no thickening of 3rd and 4th intercalaries at apex of forewing.....*pallidum*
   Median band not present on hind femur—3rd and 4th intercalaries at apex of forewing thickened.....*interpunctatum*
6. Cross veins in three or more spaces at bulla crowded together and heavily infuscated.....7
   Cross veins not more crowded at bulla than elsewhere, and not infuscated...9
7. Cross veins in seven spaces at and below bulla crowded together, widely infuscated, and more or less connected by a zigzag brown cloud; hind wing widely darkened on outer apical margin.....*pudicum*
   Cross veins at bulla crowded and infuscated in first three spaces only, not connected by a brown cloud; hind wing may or may not be somewhat darkened on outer apical margin.....8
8. Posterior half to two-thirds of abdominal tergites 1–7 largely dark brown; sternites marked with dark tranverse bands; hind wings not darkened on outer margin.....*vicarium*
   Abdomen largely white, with a median row of dark spots on posterior margin of tergites; sternites unmarked; hind wings may be faintly darkened on outer margin.....*tripunctatum*
9. Hind wing darkened on outer margin, especially near apex; small species, wing under 7 mm.; tails not marked.....*exiguum*
   Hind wing not darkened on outer margin; species varying in size; tails distinctly ringed at joinings.....10
10. Abdominal tergites largely reddish or purplish brown.....*ithaca*
    Abdominal tergites largely pale.....11
11. Small species, wing under 9 mm.....12
    Larger species, wing 10 mm. or over.....13
12. Thorax wholly pale; oblique dark streak at stigma of each abdominal segment *bellum*
    Thorax reddish brown dorsally; stigmatic dots (not streak) present on segments 3–6.....*ruber*
13. Red stigmatic stain present in forewing; dark posterior margins of tergites widest at mid-dorsal line.....*annexum*
    No red stigmatic stain in forewing; dark posterior margins of tergites even in width.....*varium*

Key to Stenonema nymphs—North Carolina species

1. Gills 1–6 pointed at tip; spines present on posterolateral angles of abdominal segments 7–9 only.....2
   Gills 1–6 rounded or truncate at tip; spines present on posterolateral angles of abdominal segments 5–9.....6
2. Wide pale submedian longitudinal streaks on dorsum of abdomen.....3
   Dorsum of abdomen unicolorous except for very narrow pale submedian pencillings.....5
3. Large nymphs, 9–11 mm.in length; yellowish brown or grey in color, the dorsal abdominal markings yellow.....*carolina*

Smaller nymphs, about 7 mm. in length; reddish brown in color, the abdominal markings whitish....4

4. Only two pale longitudinal streaks on dorsum of abdomen....sp. No. 2
   Two wide submedian and two narrower lateral pale streaks on dorsum of abdomen....*affine*
5. Nymphs 9–11 mm. in length....sp. No. 1
   Nymphs smaller, 6–7 mm. in length....*pallidum*
6. Gills 1–6 rounded at tip; trachea present in 7th gill....*tripunctatum*
   Gills 1–6 truncate at tip; no trachea present in 7th gills....7
7. Claws with two pectinations....8
   Claws not pectinate....10
8. Large stout nymphs, 10½ mm. or more in length....9
   Smaller nymphs, under 10 mm in length....*ruber*
9. Abdomen dark reddish brown dorsally, with conspicuous pale lateral patches on middle segments; venter usually unmarked, except for lateral streaks on 9....*annexum*
   Abdominal tergites 6 and 10 largely dark, others with many pale markings; conspicuous black markings usually present on sternites 8 and 9....*varium*
10. Abdominal segments with conspicuous wide black posterior border, extending completely around each segment....*vicarium*
    No such continuous black border on abdominal segments....11
11. Nymphs usually not over 10 mm. in length. Conspicuous black crescentic markings on sternites 4–9; tergites 6, and 8–10, largely dark, others with many pale markings....*ithaca*
    Larger nymphs, 12 mm. or more in length. Ventral markings inconspicuous; tergites dark reddish brown, none conspicuously darker than others....12
12. No conspicuous white markings on abdominal tergites; white bands on femora discontinuous....*pudicum*
    Conspicuous white V-shaped markings at median line of tergites 5, 7, 8 and 10; femora with continuous white transverse bands at center and near distal end....sp. No. 3

From the coastal plain

Stenonema interpunctatum Say ?

These specimens are larger than indicated for *interpunctatum* in Say's original description, and vary somewhat in marking from those which I am considering closest to the true *interpunctatum*. However, as I do not yet know how much variation, both in size and coloration, may occur in this species, I place these specimens tentatively in *interpunctatum*. Males of this species measure 8½ to 9 mm.; wing same; tails 26 mm. Vertex of head reddish yellow, marked with black on median line, and with a dark spot on each side. Black spot at center of median carina; a black dash below the antenna; very small black spot at lower corner of each eye. Bar in wing continuous over 2 or 3 cross

veins (except in one specimen, where the bar is absent). Fourth intercalary in apical margin somewhat thickened. Tails indistinctly banded with pale brown at joinings. No stigmatic dots. Other characters as indicated in Say's description. Genitalia shown in Fig. 3.

These specimens were taken in flight by Prof. Needham on April 11, 1929; several individuals were captured from Goshen Swamp in Duplin County and others from Chicod Swamp in Pitt County.

Stenonema annexum, sp. nov.

Somewhat resembles *rubromaculatum* Clem.; in abdominal markings, much like *mediopunctatum* Md. Distinguished from the latter by the type of genitalia, the distinctly banded tails, the pale thorax, in details of color of legs and wings, and in having fewer cross veins in wings. Somewhat larger than *rubromaculatum*. The description of that species is too inadequate, however, to be certain whether or not this species is synonymous with it.

Size—Body of male imago, 8½–9 mm.; wing 10–11 mm.; tails 22–27 mm. Body of female, 8½–10 mm., wing 11–13; tails 17.

Male imago

Head and thorax pale brownish to clay-colored. Abdomen hyaline whitish except last three segments, which are opaque and tinged with yellow. Reddish stigmatic area.

Head—Indistinct narrow dark line across center of median carina (not present on one specimen). Vertex dull purplish brown, often with a dark brown spot on each side. Antennæ faintly dusky.

Thorax—Geminate dark purplish brown median line on pronotum. Fore and hind margins narrowly purplish black. Purple streak on pleura, extending down on base of foreleg. Ochreous markings on pleura. Wide median whitish band on mesonotum, including scutellum. Dark brown lateral shading on metanotum. Dark brown patch on fore coxa; another wide oblique brown streak just back of foreleg.

Legs—Fore femur dusky, tinged distinctly with yellow. Other legs yellowish white. All femora with median and apical purplish bands. Fore tibia widely black at apex, others narrowly ringed with black apically. All tarsal joinings narrowly yellowish brown. Claws dark brown basally. First foretarsal joint about ½ the length of the second (not more than ½ its length).

Wings—Hyaline, iridescent. Longitudinal veins yellowish, especially

those on the costal border. Cross veins thicker than longutidinal; dark reddish brown in color. Humeral cross vein particularly thickened. 5–6 costal cross veins before the bulla, about 11 beyond. At bulla, 2 cross veins in costal space, 2 or 3 in subcostal space. Stigmatic area with reddish stain in most specimens. Veins of hind wing almost colorless.

Abdomen—Distinct stigmatic dots present on tergites 2–8 (less prominent on 2 and 8). Tergites 1–6 with very narrow dark posterior margins, thickest at the median line, thus giving the appearance of dark transverse median dorsal marks. These most prominent on tergites 3–6. Venter pale, unmarked.

Genitalia—See Fig. 16.

Tails—White. Alternate segments narrowly ringed with purplish black, except at base, where the first 6 or 7 segments are often not marked.

Female imago

In general, similar to male, except for usual differences of sex. Posterior margins of tergites somewhat more distinctly and regularly dark than in male.

Nymph

Size—Body (female) 10½–11½ mm.; tails 17–18 mm.

General appearance—Dark reddish brown dorsally; legs and tails distinctly lighter in color than body. Head and abdomen with numerous tiny light dots on dark areas.

Head—Frontal area dark reddish brown; margin fringed with hairs. Lateral margins colorless except for a narrow dark band from eye to outer margin. Vertex and occiput lighter brown, with white areas next to eyes, and a large whitish diamond-shaped area at center.

Thorax—Two dark brown longitudinal bands on each side of pronotum. One extends obliquely forward on each side of median line. The other and outer band, quite irregular in outline, lies near the outer margin and extends forward so that its anterior end almost touches the inner band. Lateral margin pale yellowish. White blotches laterad of the outer dark band, and between the two dark bands. A few small light marks near wing bases, on mesonotum.

Legs—Pale yellowish. Femora with 3 irregular dark brown transverse bands and a small dark spot near center of band nearest base of leg. Two dark bands on each tibia. Tarsi light brown in basal half. Tips of claws brown. Claws with 2 small pectinations.

Abdomen—Dark reddish brown dorsally; tiny dots most numerous on lateral areas. Dark median stripe extends length of dorsum. Tergites 2–7 have a blackish spot on each side, half-way to lateral margins, and posterior to the middle of each tergite. Anterior to this dark spot is a large white area, bounded by dark brown, extending forward and outward. Thus the sides of the tergites next to the gills appear white-blotched, with dark dots below. Anterior margins of 4–5 and 8–10, irregularly and narrowly white. Lighter area on each side of dark median line on tergites 4–5 and 7–9. Short lateral spines on 7–9; the spine on 9 shorter than on 8. Ventrally pale yellowish red. One specimen shows faint lateral brown streaks on each sternite, faint dark median marks at anterior margin of each, and an oblique brown mark on each side of 9. All other nymphs are unmarked ventrally.

Gills—Light greyish purple. Thread-like seventh gill unusually long and slender.

Tails—Pale greenish yellow; in mature nymph, shaded basally with light brown.

Holotype—Male imago. Goshen Swamp, N. C., April 11, 1929. Collector, Prof. J. G. Needham. No. 1122.1 in Cornell University collection.

Allotype—Female imago. Same data. No. 1122.2 in Cornell collection.

Paratypes—3 male imagoes, 9 female imagoes; 2 male sub-imagoes, 3 female subimagoes. Goshen Swamp and Chicod Swamp, April 11, 1929. Same collector. No. 1122.3–19 in Cornell collection.

Included among the paratypes are a male and female imago, slightly smaller and paler than the others, and in which the stigmatic area is opaque whitish with no trace of red. In other details they are similar to the remainder of the paratypes. Nymphs were collected from several small tributaries of the Cape Fear River near the little village of Buies Creek, and from tributaries of the Neuse River near Ft. Barnwell, in April 1930. Two female imagoes reared from these nymphs seem similar to those from Goshen and Chicod Swamps.

From the piedmont

Stenonema pallidum, sp. nov.

A small slender species from the Cascades, near Danbury. Nymphs were collected on May 12, 1929, and on May 18, 1930. Several imagoes of both sexes were reared. This species is close to the one I am calling

interpunctatum Say, but is considerably paler, and the third femur has a distant median band.

Male imago

Size—Body 6½–7 mm.; wings 7½–8; tails 20–22 mm.

Head—Pale yellowish. Black dash below each antenna. Small reddish spot in center of vertex. Base of antenna white. Basal portion of filament faintly dusky, tip pale.

Thorax—Notum pale, yellow to yellowish brown. Pleura slightly deeper yellowish. Black longitudinal stripe on each side of pronotum. No other markings. Yellowish ventrally, with deeper orange area at each side near base of third leg.

Legs—Yellowish white. Fore femur yellowish brown with conspicuous purplish black median and apical marks. Similar but paler marks on 2nd and 3rd femur. Fore tibia purplish black at apex. Joinings of fore tarsus very faintly brownish, as is apex of last tarsal joint of other legs. One claw brownish, on all legs. Fore leg about as long as body.

Wings—Hyaline, iridescent. Basal cross veins of costal, subcostal, and radial spaces, and a few beyond bulla in same spaces, black and thickened. Other cross veins rather dark brown, those in basal half of wing rather pale. Dark dash in wing short, dumb-bell-shaped, including one or two cross veins. Fourth apical intercalary narrowly darker than others. 4 to 5 cross veins in costal space, before bulla; 2 oblique ones at bulla, and about 12 beyond. The first two of these are widely separated. Outer intercalaries of hind wing dark.

Abdomen—Whitish. 1–7 semi-hyaline, 8–10 opaque, faintly yellowish dorsally. Each tergite rather widely margined posteriorly with purplish black. No stigmatic dots. Unmarked ventrally.

Genitalia—Very similar to those of the species I believe to be the true *interpunctatum* Say. A small protuberance on each side of the inner margin of the penes, present in all species of *Stenonema*, seems to be turned outward occasionally, as is the case in the specimens of this species.

Tails—Pale, unmarked.

Female imago

Size—Body 6–7½ mm.; wing 9–10; tails 17.

Cross veins of forewing somewhat darker and more prominent than in the male, especially in the basal half. Small black dot on face at lower

corner of each eye, as well as black dash below antenna. On vertex, a black spot on each side, in addition to central reddish dot. Otherwise similar to male.

Nymph

Size—Body 6–7 mm.; tails 10–11 mm.

General appearance—Slender light reddish brown nymph. Abdomen paler dorsally than head and thorax. Abdominal tergites narrowly dark-ringed. Median pale streak on dorsum of abdomen.

Head—Bright reddish brown, especially in central area anterior to ocelli. A narrow, light line from outer corner of eye to lateral margin; epicranial suture also narrowly white. Anterior to median ocellus a small white spot, and a somewhat larger one laterad of each lateral ocellus. Antennae pale brown.

Thorax—Notum bright reddish brown. Antero-lateral angles of pronotum pale, also one or two small spots on each side. Mesonotum also mottled with small light spots. In mature nymph, a black bar on each side of pronotum is evident. Median suture of mesonotum pale. Ventrally, pale yellowish. Narrow dark line at posterior margin of mesosternum; small brown spots at each side between 2nd and 3rd legs.

Legs—Yellow to pale yellowish brown. Femur with brown median band and darker apex. Tibia smoky, paler at each end. Tarsus dusky, apex pale. Claw dark-tipped.

Abdomen—Pale reddish brown dorsally. Each tergite narrowly purplish black on posterior margin. Central paler median streak, bounded on each side by a very narrow paler line, shaped thus: ( ). No other dorsal markings. Short postero-lateral spines on 8 and 9, about equal in length. Anterior segments pale laterally, beneath gills. Ventrally pale yellowish. Lateral margins of 7–9 pale brown; no other markings.

Gills—Dark greyish purple; tracheae distinctly dark purple.

Tails—Pale yellowish brown. Near base, short dark spines at every joining; beyond base, spines at every 2nd or 4th joining. No spines in distal half. In central part, alternate joinings narrowly darker.

Holotype—Male imago, reared. The Cascades, near Danbury, N. C. May 21, 1929. No. 1123.1 in Cornell University collection.

Allotype—Female imago, reared. Same locality, May 21, 1930. No. 1123.2 in Cornell collection.

Paratypes—2 male imagoes; 1 female imago; 5 male sub-imagoes; 5 female sub-imagoes; 8 nymphs. Same locality, May and early June, 1929 and 1930. Nos. 1123.3–23. In Cornell collection.

Stenonema sp. No. 1.

Nymphs very similar in color pattern and general appearance to those of *S. pallidum*, but about ⅓ longer, and relatively more slender, were taken at the Cascades in May, 1930. Females only were reared. These are very much like females of *S. pallidum*, but slightly larger, and with no black mark beneath the antennae. Cross veins of the wings are somewhat less numerous. Body of female imago, 10–11 mm.; wings 11 mm.; tails 25 mm. Nymphs measure 9–11 mm., tails 14 mm. In most of these nymphs, no dark posterior border is present on the tergites. In alcohol, they are pale reddish brown in color, but in life appeared much darker brown.

Stenonema affine, sp. nov.

A pale species, lacking the dark dash beneath the antennae and the dark stripe on the pronotum. No median band on femur of second leg.

Male imago

Size—Body 7–8 mm.; wing 8–9 mm.; tails 18 mm.

General appearance—Pale whitish, the thorax and tip of abdomen creamy yellow.

Head—Pale yellowish. No dark spot on face below antenna. Small dark spot at lower corner of each eye. No dark spot on median carina. Vertex with a small central reddish spot and two dark lateral dots. Antennae dusky.

Thorax—Entirely pale creamy yellow with faint pinkish tinge. No dark lateral streaks on pronotum. Some of the sutures of the notum and pleura are *very narrowly* darker.

Legs—Whitish, the fore leg tinged faintly with yellowish brown. Fore femur with median band and black marks at apex. Other femora lacking the median band, and the apical markings very faint. Apex of fore tibia, and last foretarsal joint, brown. Claws and tarsal joinings of all legs pale brown.

Wings—Semi-hyaline. Costal cross veins slightly thickened, especially toward the costa. 4 or 5 before the bulla, 13 or 14 beyond it;

of these, the first two are widely separated, the next five close together, the remainder more evenly spaced. 3 subcostal and 2 radial cross veins at bulla, the latter connected by the customary dark dash. Fourth intercalary on apical margin not thickened. All longitudinal veins pale. Cross veins brown, paler in basal half of wing.

Abdomen—Segments 1–8 semi-hyaline, white; 8–10 opaque, tinged with yellowish. Posterior margins of tergites marrowly purplish black. No stigmatic dots.

Genitalia—Differ but slightly from the coastal plain species.

Tails—White basally, the extreme distal portion very faintly smoky. Unmarked.

Female imago

Similar to male except for usual differences. Costal and radial cross veins before the bulla rather more widely margined than in the male. Body 7 mm.; wing 9 mm.; tails 12 mm. (may be broken at tip).

Nymph

Size—Body 7 mm.; tails 15 mm.

General appearance—Small slender nymph. Light reddish brown color, the head particularly reddish. Abdomen dorsally with 6 longitudinal white stripes.

Head—Bright red-brown. Anterior to median ocellus, a large white mark shaped like a mayfly's hypophyarnx. Another large white mark laterad of each lateral ocellus. Lateral margins pale yellowish, with narrow central brown band. Small light dot on each side of frontal border. A median and two lateral light spots on occiput. Antennae pale brown.

Thorax—Wide pale mid-dorsal band the length of the thorax; widest at anterior margin of pronotum. Pronotum white on lateral margins except anterior angle, which is brown. Remainder of pronotum brown except for three parallel transverse white dashes on each side. Few small light marks on mesonotum near wing roots. Ventrally whitish, with transverse brown band across the mesosternum.

Legs—Pale brown. Femur pale yellowish at each end, and with a pale central band. Tibia white apically, and a white band near basal end. Apical half of tarsus white.

Abdomen—A wide longitudinal white band the length of the abdomen on each side of the brown median dorsal streak. These pale bands somewhat irregular, since the brown median streak is widest at center of

each tergite. A narrow light line on each side close to the lateral border, and between this and the central wide light bands, another narrow light line. Postero-lateral spines on 8 and 9, about equal in length. Ventrally yellow, prominently bordered and marked with reddish brown. Sternite 9 brown except a semi-circular area on anterior margin at median line, and a narrow light area on each side. Wide brown band extends longitudinally on each side of venter, its inner margin widest near center of each sternite. On 6 and 7, inner extensions of these lateral brown bands meet, forming a more or less complete transverse band near center of each of these sternites.

Gills—Light greyish purple. Tracheae distinctly dark purple.

Tails—Brown for short distance at base; remainder yellowish, very narrowly dark brown at alternate joinings. A circle of stout dark spines at each pale joining.

Holotype—Male imago, reared. Caraway Creek, Uharie Mountains, N. C., near Sophia, April 23, 1930. No. 1124.1 in Cornell University collection.

Allotype—Female imago, reared. North Fork of Potomac River at the Smoke Hole, W. Va., Aug. 9, 1930. No. 1124.2 in Cornell University collection.

Paratypes—2 male imagoes, Smoke Hole, W. Va., Aug. 8, 1930; 2 male subimagoes, Caraway Creek, N. C., May 21, 1930; 3 nymphs, Caraway Creek, May 20, 1930; 2 nymphs, Smoke Hole, W. Va., Aug. 7, 1930. No. 1124.3–11.

Nymphs of this species were found also in small streams near Denton, N. C., on June 10, 1929, and near Spero, N. C., on April 29, 1929. The markings of the head and pronotum of the nymph, and its bright reddish brown color, serve to distinguish it from other species having the abdomen prominently striped.

Stenonema tripunctatum Bks.?

Two nymphs, not quite typical of *tripunctatum* Bks. but very similar, were taken from a small stream near Spero, on Feb. 18, 1930. These nymphs possess the row of dark spots on each side of the venter of the abdomen, but the spots are lacking on sternite 9. A male imago was reared from one of these nymphs. Its abdomen, while marked as in typical *tripunctatum* specimens, is washed with brown much as in

femoratum Say. The hind wings are distinctly dark bordered. Genitalia are typical for *tripunctatum* Bks. See Fig. 14. A female nymph similar to those taken at Spero was found in the Uharie River near Farmer. It transformed on April 7, 1929. The brownish wash of the abdomen and the dark-bordered hind wings are present on this specimen also.

Stenonema vicarium Wlk.

Nymphs which seem to be those of *vicarium* Wlk. were taken at four different localities in the piedmont. Dates of collection are as follows. From a small stream near Spero, mature nymphs were taken on Feb. 21, 1930, and on March 1 and 29, 1929; from the Uharie River near Farmer, on April 3, 1929; from Caraway Creek near Sophia, April 13, 1930; and from a stream near Asheboro, in middle April, 1929. Two female and male imagoes were reared from these nymphs. The imagoes are considerably paler than typical *vicarium* imagoes which I have reared from the vicinity of Ithaca, N. Y., so much so that I had thought them to be of a different species. Careful comparisons of the North Carolina material with nymphs and imagoes of the New York specimens lead me to believe, however, that my North Carolina species is in reality a light-colored form of *vicarium*. The venation is considerably paler in the Carolina specimens, the cross veins being dark brown only in the costal margin, and light brown elsewhere in the wing. In the New York specimens, on the other hand, all cross veins are so dark a brown as to appear almost black. Other characters, both of nymphs and imagoes, are very similar for the two forms, aside from the lighter color already noted, of the southern specimens. The genitalia are likewise very similar.

Stenonema pudicum Hag.?

Female imagoes, captured as they flew over the water while ovipositing, are in my collection from the Cascades near Danbury. These females were taken on May 3, 1930. The stream which flows through the Cascades is apparently a tributary of the Dan River, cutting a small gorge through a portion of the Sauratown Mountains. From nymphs collected in this stream on May 18, 1929, and May 3 and 18, 1930, several other females were reared, also one male imago and two subimagoes. The males are unusually small for the size of the females, and much paler in color.

The nymphs differ somewhat in color pattern from nymphs of *pudicum* Hag. taken in the mountain area of the state. I had thought that the Cascades specimens represented a different species. However, there are so few differences, both in nymphs and imagoes, between these and the mountain specimens which Dr. McDunnough has kindly identified as the true *pudicum* Hag., that for the present I place all of them in this species. As the nymph of *pudicum* does not seem to have been described, I present a description of it In listing the species from the mountain localities, the differences between the nymphs will be indicated. I make brief mention also of the differences found between the imagoes of the piedmont and mountain regions.

Nymph (from Cascades)

Size—Body (female) 12–14 mm.; tails 18–20 mm.

General appearance—A smooth-appearing nymph, rather stout. Reddish brown dorsally, without conspicuous markings. Ventrally pale, the apical segments yellow, and marked with dark brown.

Head—Numerous small light dots sprinkled over dark areas. Lateral areas light, with rather wide brown central band from eye to outer margin. Paler spot in front of each ocellus; a small dark spot behind each lateral ocellus. A pale area on each side of the posterior margin of occiput; small light area on median line. Basal segment on antenna largely light; next two dark brown, remainder light brown.

Thorax—Dark brown triangular area, its base on margin, occupies center of anterior margin of pronotum. On each side of this, a narrow white strip, then another dark brown area extending almost to the lateral margin. Enclosed in this dark area is an oblong white patch. Lateral margins pale except for brown streak in central portion. Posterior border narrowly dark, widest at median line. A small light comma-shaped mark is often present on each side, near posterior border. Mesonotum with four darker patches on anterior margin. Irregularly marked with small light and dark areas. Ventrally pale yellowish, sutures light brown.

Legs—Femur largely reddish brown, with three zigzag white bands, often incomplete. Each end is light in color. Tibia reddish brown except for white apical band. Base and apex of tarsus pale; central area dark brown. Tips of claws dark. Claws not pectinate. In fully-mature nymph, a purplish spot in center of each femur.

Abdomen—Each tergite narrowly dark on posterior margin. Dark area along anterior half of median line, on most tergites. A white

sub-median streak on each side of this dark portion, most evident on 5 and 7–10. Irregular light area along anterior margin of each tergite. On 1 and 2, this occupies most of the tergite. A lateral dark patch on each side of each tergite, adjoining the gills. Usually some small white areas near this. Postero-lateral spines present on 3–9, short on 3–6, longer on 7–9; longest on 8. Spine on 9 almost as long as that on 7. Ventrally yellow, this color deepening apically. Faint brown lateral streak on each side of venter. Sternite 9 has a wide dark brown longitudinal streak on each side, extending the length of the segment. Anterior ends of these bars usually connected by a transverse band, which dips down slightly at median line. Oblique dark brown subventral dashes on all sternites. Areas between these filled in with solid brown, in shape of a sector of a circle, on sternites 6–8, and faintly on 4–5.

Gills—Dark purplish grey.

Tails—Greenish yellow, becoming brown basally in fully-mature nymph. Distal half barred with dark brown, these bars being 2 to 3 segments in width. Tail segments very short, especially near base. Joinings dark brown. Circle of long dark spines at each joining basally; in middle of tail, spines at alternate joinings; none present in distal half.

Imagoes

Female imagoes differ from the mountain specimens of the species as follows. Head not so definitely bordered with purple on the posterior margin. Thorax more ruddy before the forewing, and sometimes lacking the cream-colored area next to the mesonotal spine. Tergites of abdomen entirely lacking the median dark sagittate streak. Their posterior margins narrowly and regularly dark, without the purplish wash on the posterior half of the segment, as found in the mountain specimens. Wings somewhat longer and slightly wider, the cross veins slightly darker and more prominent.

Male imagoes are much smaller in size, much paler, and in general differ from the mountain forms as do the females, except that the venation is definitely paler. Genitalia very similar to the mountain specimens.

In addition to the specimens taken at the Cascades, others of the same species were found near Greensboro. Both nymphs and imagoes from this locality resemble the mountain forms much more closely than do those from the Cascades. Nymphs are much less prominently marked ventrally, often having only the oblique dark subventral dashes.

Specimens were collected in April, 1929, and several female imagoes reared.

Stenonema ruber McD.?

This species is not quite identical either with *ruber* McD. or *pulchellum* Walsh, according to specimens of each of these species which Dr. McDunnough has kindly sent me for comparison. In some respects it is intermediate between the two, but in the appearance of the wings in particular it is closer to *ruber* McD. Nymphs, while very similar to those of *ruber*, show some rather constant differences in color pattern. It does not seem advisable to describe these specimens as a new species, however, but rather to place them tentatively in *ruber*, which species they most resemble.

A comparison with typical specimens of *ruber* McD. is added below.

Male imago—Somewhat smaller in size. Paler in color, particularly the thorax and terminal segments of abdomen. Abdomen usually semi-hyaline white, without smoky tinge. Stigmatic area of forewing opaque white, no trace of reddish stain. Purplish streak running down on base of foreleg, usually present. Tails in some specimens without dark joinings. Stigmatic dots and dark bands on posterior margins of tergites usually present, but one or both may be absent. Cross veins in costal area of forewings slightly thicker and darker than in *ruber*. Veins of hind wing, and of outer margin and lower portion of forewing often almost colorless. Other cross veins brown, very similar to *ruber* and less numerous than in *pulchellum*. Legs pale yellowish white, only the fore femur slightly deeper yellow, and much paler than in either *ruber* or *pulchellum*. Brownish or purple tinge at distal end of each femur. Distal ends of 1st and 2nd tibiae dark brown. Median purplish band on femur sometimes indistinct or absent on hind leg. In fore tarsus the first joint varies in length in different specimens from about $\frac{1}{3}$ of 2nd joint to $\frac{1}{2}$ or almost $\frac{2}{3}$ of the second. It may thus vary on the two fore legs of the same insect. In many males of this species, the fore leg is long in proportion to the body, sometimes exceeding it slightly in length.

Nymph—Considerable variation in amount of pigmentation of dorsal surface, which is either light yellowish or dark reddish brown. Extent of the dark ventral markings is also variable. A typical nymph of the yellowish brown variety, well-marked ventrally, compares with a typical *ruber* nymph as follows. Gills very faintly grey (in *ruber*, dark purplish

grey). Hind margins of femora and tibiae bear much shorter hairs than in *ruber*. Abdominal spines and pale ventral surface similar in both. In typical *ruber* a very dark U-shaped mark is present on sternite 9, and a somewhat mushroom-shaped dark mark on 8; all other sternites unmarked. North Carolina nymph has same marks on 9 and 8, likewise a faintly dark dash at center of anterior margin and an oblique subventral streak on each side, on sternites 4 to 7. The mark on 8 is rather that of an inverted mushroom, and the U-shaped mark on 9 is often incomplete on the anterior margin.

Many nymphs of this species were collected, and many imagoes reared. So much variation was noted among these reared imagoes that 25 of the darker specimens were selected for special examination. Of these, 12 were males. Nymphs of these 25 specimens were so similar as to preclude the possibility of two species being involved. Presence or absence of stigmatic dots; of dark bands on the tergites, posteriorly; of dark joinings on the tails; of the color of the thoracic notum; and of the median band on the femur, were the points observed. Results are as follows. One male and 1 female show no slightest trace of dark banding at the tail joinings and in 4 others the banding was very pale. One male has a yellow thoracic notum. Five females show no indications of stigmatic dots, which are very faint on 12 other specimens, of which 5 are males. In 1 male and 2 females, no median band is present on the hind femur. In 1 male and 2 females (same specimens) there is almost no indication of dark borders on the tergites. In several other males, not included in the above specimens, the entire thorax is yellowish clay-color. In most males the terminal segments of the abdomen are yellowish brown, with no trace of darker reddish brown.

So much variation accounts for the great difficulty experienced in determining species accurately when the main characters used to distinguish these species are such variables as darker bands at the tail joinings, stigmatic dots and dark borders on the tergites. Yet it is by a combination of such characters that most species in the *pulchellum* group must be separated. Much rearing work must be done, both in this and the *interpunctatum* group, before the limits of variability can be determined, and species accurately defined.

Specimens of this species were collected from several localities in the piedmont. Imagoes emerged during April and May, likewise in September and early October. No collecting was done in this area between early June and mid-September. The largest number of specimens were found in Caraway Creek, in the Uharie Mountains near Sophia. Other

localities are as follows. Big Alamance Creek, in three different places; Little Alamance Creek at Troxler's Mill; a small stream in the outskirts of Greensboro; a small stream near Spero; the Uharie River near Farmer; Middle Below Creek; and at the Cascades near Danbury, in the Sauratown Mountains.

Stenonema varium, sp. nov.

A rather large species of the *pulchellum* group. Imagoes vary considerably in the amount of dusky tinge present on the abdomen, some being almost wholly pale. Stigmatic dots usually present. Tails white, joinings dark. Abdominal tergites dark on posterior margins.

Male imago

Size—Body 9–11 mm.; wing 10–11 mm.; tails 28–35 mm.

Head—Pale yellowish brown. No marks on frons. Filament of antenna pale brown. Faint orange dot at center of vertex; on each side of this a short curved dusky mark, quite faint.

Thorax—Yellowish brown, darkest on metathorax and on each side of mesothoracic scutellum. Broad whitish areas anterior to wing roots, on pleura between 2nd and 3rd leg, and at base of fore leg. Scutellum of mesothorax white except for a narrow brown median line. Narrow white area immediately anterior to scutellum, and on each side of metathoracic spine. Anterior and posterior margins of pronotum narrowly purplish black. Double median black line on pronotum. Principal sutures of thorax very narrowly dark brown. Sternum very similar in color to notum, slightly darker than pleura.

Legs—Antecoxal pieces brown, coxa and trochanter pale. A purplish streak extends upward on the thorax from the base of the fore leg. Femora pale yellowish, with median and apical purplish brown bands. Tibiae paler than femora, purplish brown at apex. Fore tarsus pale, the joinings very narrowly darker. (In some specimens, entire tarsus faintly dusky.) Other tarsi pale yellowish, the joinings narrowly brown (last joint and claw dusky, in some specimens). First joint of fore tarsus one-half or slightly more than one-half the second joint.

Wings—Semi-hyaline. Both wings have a pale brown cloud near the point of attachment, with pale areas at the extreme costal and anal regions. Brown bands extend forward along the costa and subcosta as far as the humeral cross vein, which is heavily infuscated. No noticeable crowding of cross veins at bulla. Stigmatic area opaque

whitish, without red stain. Costa, subcosta, and radial sector of fore wing yellow. Other longitudinal veins pale yellowish brown. Cross veins dark reddish brown, thicker than the longitudinals. Hind wing very similar, except for entirely pale veins in anal region. 4–5 costal cross veins before bulla, about 8 beyond.

Abdomen—Tergite 1 largely dull purplish grey. Segments 2–6, and basal half of 7, semi-hyaline, white. Apical half of 7, and 8–10, opaque, pale yellowish brown. All tergites with purplish black posterior margins, becoming somewhat wider on the anterior sclerites. Stigmatic dots present on 2–7. On 2–5, a narrow purplish black transverse streak extends from the stigmatic dot laterally almost to the median line, running parallel and close to the dark posterior margin. Median line of tergites 1–3 a dull purplish grey streak, with lateral extensions on each side near the anterior margin. Venter unmarked, the ganglionic track opaque white.

Tails—White. Joinings narrowly purplish brown, alternate joinings wider. Becoming faintly dusky at tip.

Genitalia—Similar in form to others of this group. Forceps silvery white; penes and forceps base pale yellowish brown.

Variations in color pattern—

(a) Abdominal tergites 1–4 largely dull purplish grey, except for pale areas in the anterior lateral angles and a pale band on the anterior margin. Median line bifurcate. Faint dusky area on each tergite bordering the pale pleural joinings. Pale opaque submedian streaks on each tergite may be evident.

(b) Abdomen much paler, the greyish markings of tergites 1–3 or 1–4 almost wholly obsolete. Thoracic notum a somewhat deeper reddish brown. Fore femora, and all segments of other legs, pale yellowish brown. No dusky marks on vertex of head.

(c) Pale specimen, the stigmatic dots practically wanting.

(d) Markings on abdominal tergites 2–3 consist of a grey median line and grey spots on each side of this, in addition to the transverse streak from the stigmatic dot. Faint dusky spot on each side of median carina of face.

(e) Resembles variation (a), but the dusky markings occur on tergites 1–7, although less extensive on 7 and 8 than on the anterior tergites. The purplish median line extends to the tip of the abdomen. Stigmatic dots very small, and directly anterior to each is a pale area

enclosed by a yellowish brown circle. Faint dusky stain on each side of medioventral line, near center of each sternite.

Female imago

Body and wing, 11–12 mm.; tails 28 mm. Head and thorax pale yellowish. No dusky curved marks on vertex. Faint purplish black pencillings above base of each leg. Legs pale yellowish white, marked as in the male. Abdomen pale. Posterior margins of tergites 1–5 narrowly dark; remaining tergites wholly pale. Stigmatic dots present but faint. No median or lateral greyish markings on any tergites. Bases of wings lack the pale brown cloud present in the male. Joinings of tails faintly dark, but paler than in the male.

Variation (a). All tergites narrowly dark on posterior margins. A pale brownish mediodorsal line extends the length of the abdomen. Tergites 1–5 with pale purplish brown shading on each side of median line.

Nymph

Size—Body 9–12 mm.; tails 15 mm.

General appearance—Reddish brown, the abdomen paler than the thorax, and having a banded appearance.

Head—Reddish brown, sprinkled with many minute pale dots. Light areas anterior to median ocellus; laterad of each lateral ocellus; at antero-lateral angles of each eye; and along the lateral margin of the head. Small light areas also at center and on each side of the posterior margin.

Thorax—Reddish brown. Lateral margin of pronotum colorless, except for the brown antero-lateral angle. This pale area extends inward into the surrounding brown border in one or two round emarginations. A large pale spot near center of pronotum on each side. Toward the median line from this spot is a dark area, and a transverse black line passes through the light spot. Young nymphs may have other light areas near the median line at the anterior margin. Pale narrow median line on pro- and mesonotum, widest at anterior margin of mesonotum. A few pale spots on mesonotum near wing roots.

Legs—Pale yellowish. Femora with two wide brown transverse bands, one on each side of middle, and a narrower dark band near each end. Tibia has a brown basal band and another beyond the middle. Tarsus narrowly pale at base and more widely pale at apex, the remaining portion brown. Claws amber, tipped with reddish brown. Each has two pectinations, not very prominent.

Abdomen—Tergites 1–4 very pale yellowish brown, with dark median line in anterior half of each. A dark brown comma-shaped mark, the tail directed anteriorly, is present on each side of the median line near the center, in tergites 3–5, and 7. Tergite 5 like 4, but more yellowish. Tergites 6, 8, and 10 largely dark reddish brown, each with yellow submedian streaks in anterior half. Tergite 8 is likewise yellow on the posterior margin, at center. Tergites 7 and 9 with yellow background and many irregular reddish brown markings. These include a dark median triangle in the anterior half; a variation of the comma-shaped mark; brown lateral margins; and an irregularly triangular brown area occupying a considerable portion of the remainder of each side. Postero-lateral spines are present on segments 3–9; weak on 3 and 4, better developed on 5 and 6, longest on 7–9. Of the latter, that on 8 is slightly the longest.

Ventrally yellow, paler on the anterior sternites. Anterior margin of each sternite very narrowly dark. Postero-lateral extensions brown. Prominent blackish brown markings on the posterior sternites, varying considerably in extent and shape. Typically, a dark brown crescent is present on 9, extending forward to the anterior margin. A median spot occurs at the anterior margin of 8, sometimes divided into two portions connected at the center. On each side of this, a dark spot. In all other sternites, faint brownish oblique submedian streaks arise from the anterior margin, and at the outer end of each (i.e., near center of sternite on each side) is a dark brown dot. Between these and nearer the median line, another faint dot may occur. General appearance is thus of a row of dark dots on each side, in addition to the markings on 8 and 9.

Tails—Greenish in immature nymphs, brown in mature specimens. In distal half to two-thirds of each, groups of 2 to 3 dark segments are interspersed between groups of 2 or 3 pale segments, thus presenting a distinct banded appearance. In basal half, each joining is encircled by stout spines, longer on alternate joinings. Rather long hairs also arise from these joinings.

Genitalia of mature male nymphs dark brown.

Variations in color pattern—

(a) Ventral markings may consist of two dark brown oblique lateral bands on sternite 9, these bands not meeting at the top nor attaining the anterior margin. The rows of dark spots in the other sternites may be faintly indicated, or entirely absent. Dark spot on 8 may be entirely lacking.

(b) Crescentic mark present on 9, and a two-branched mark on 8, but rows of dots on other sternites absent or extremely faint.

(c) The dark mark on 9 may be straight along the anterior margin, thus appearing angular rather than crescentic. Mark on 8 may have the form of an inverted mushroom.

(d) The mark on 8 may be somewhat crescentic, that on 9 likewise a crescent, and another faint crescent may be present on 7.

Holotype—Male imago, reared. Big Alamance Creek at Tom's Place, south of Greensboro, N. C., April 5, 1930. No. 1125.1 in Cornell collection.

Allotype—Female imago, reared. Same locality, April 12, 1930. No. 1125.2 in Cornell collection.

Paratypes—11 male imagoes, 14 female imagoes, all reared. Big Alamance Creek at Tom's Place, April 10–17, 1930; and April 28, 1929; Caraway Creek near Sophia, April 15–27, 1930; near Tabernacle church south of Greensboro, May 1–9, 1930; Greensboro, N. C., April 23–28, 1930; Polecat Creek south of Greensboro, April 9–16, 1930. Also 13 nymphs, from the above localities during April 1929 and 1930; also from the Uharie River near Farmer, N. C., and from a stream 12 miles north of Greensboro. No. 1125.3–40.

This species was more common in the piedmont than any other of the Heptagenine group. In addition to the localities listed for the type material, this species was taken in the following places. Near Spero, N. C., April 29, 1929; at the lake near Liberty, April 23, 1929; near Denton, May 2, 1929; and at Asheboro, April 3, 1929.

Stenonema varium would seem to be rather closely related to *S. rubromaculatum* Clem. Judging by Clemen's description, *varium* may be distinguished from his species by (1) the absence of a red stain in the stigmatic area of the forewing, (2) the larger size, and (3) the greyish median and lateral markings of the anterior abdominal tergites. The nymph is paler, has a more distinct dorsal color pattern, and lacks the extreme hairiness and the granular appearance said to be characteristic of the nymph of *rubromaculatum*.

Included among the typical *varium* nymphs taken at Polecat Creek are some others which are distinctly more hairy. In these, also, the ventral markings of the abdomen are reduced to rows of indistinct dots on all sternites but 9. On this latter sternite, markings consist only of

a lateral dark streak on each side, which is broken up into an anterior and a posterior portion, of which one or the other may be entirely absent. Dorsal markings, while somewhat darker in color, are very similar to those of more typical nymphs, with the addition, in some specimens, of an almost continuous dark median line on the abdomen. Imagoes reared from some of these nymphs are similar to pale specimens of the typical form.

Stenonema exiguum, sp. nov.

See description under species from the mountain area.

A single female imago was taken at the lights of the auto near Hamburg Lake, on June 1, 1929.

Mountain region

Stenonema sp. No. 2.

A single male imago, reared on July 30 from a nymph taken in the Ocona Lufty River, differs from specimens of *S. pallidum* in lacking the dark dash below the antennae. In this respect it is similar to *Stenonema* sp. No. 1 from the Cascades. The nymph is dark reddish brown in color, the lateral areas of the middle abdominal segments being conspicuously pale. The pale irregular subdorsal lines on the tergites are wider, especially on the anterior segments, very much as in nymphs of *S. affine.* Body of male imago measures 7 mm.; wing 8½ mm.

Stenonema sp.

Very elongate dark reddish brown nymphs were found in the Ocona Lufty River on June 22, 1930. No imagoes were reared. These nymphs are somewhat larger and much darker in color then nymphs of *Stenonema* sp. No. 1 from Cascades, and the pale subdorsal lines are almost obsolete. Length 10 to 11 mm.

Stenonema carolina Bks.

A single female imago of this species was caught in flight in the Blue Ridge Assembly grounds near Black Mountain, on June 18, 1929. A tributary of the Swannanoa River flows through the assembly grounds. Another female imago was captured at a small stream on the State Test Farm near Swannanoa on June 18, 1930. An immature nymph, probably of this species, was found in this same small stream. I have

recently reared imagoes of this species from nymphs taken in the vicinity of Ithaca, N. Y. A description of the mature nymph follows. For the genitalia of the male imago, see Fig. 2. The specimen from which the mount of the genitalia was made, was taken from the North Fork of the Swannanoa River, N. C., on May 31, 1912, by Dr. Beutenmuller, and presented to the Cornell collection.

Nymph

Size—Body (male) 9–10 mm.; tails 10 mm.

General appearance—Slender yellowish brown nymph, the brown definitely tinged with grey. Yellow longitudinal stripes on dorsum of abdomen.

Head—Dark reddish brown. Lateral margin yellowish white. A conical white spot anterior to the median ocellus, and another light spot laterad of each lateral ocellus. Posterior margin of head pale, except for narrow dark border on each side of median line. Epicranial suture white. Antennae purplish grey at base; remainder pale greyish white.

Thorax—Lateral margins of pronotum pale. Large pale circular spot at antero-lateral angle, in which is a small dark spot on anterior margin. Large yellowish white transverse mark on each side of pronotum, widest laterally. Median line pale. Pale spot at median line on posterior margin, another small curved light spot on each side. A black mark may be present on each side near the posterior margin. Mesonotum with pale median streak, widest anteriorly. Few pale marks near wing roots. Pale ventrally, with brown areas in center of prosternum, anterior to bases of 2nd and 3rd legs, and on antecoxal pieces.

Legs—Pale with smoky tinge. Coxa and trochanter each with a brown blotch. Femur pale near each end, and with a narrow irregular median band; otherwise greyish brown. A smoky longitudinal streak near fore margin. Tibia yellowish, with two smoky transverse bands. Tarsus pale distally, basal half pale smoky brown. Claws rather stout; no pectinations near tip, but usual median spine at center on inner margin. Claws tipped with orange-brown.

Abdomen—Dark smoky brown median stripe on dorsum, margined on each side by yellow stripe, which is narrow on tergites 1–6, and progressively wider on 7–10. On 8–10, presents appearance of yellow background with narrow dark median stripe. Lateral margins pale on 1–6. On 7–10, dark brown at extreme magrin, with yellow stripe next to brown. Wide rhomboidal brownish grey patches occupy most of the

remainder of each tergite. In each dark patch is an incomplete yellow streak, and at postero-lateral angles of each, a darker brown spot. General effect is of greyish abdomen with four complete and two incomplete yellow longitudinal stripes. Posterior margins of tergites brown. Long postero-lateral spines on 8 and 9, and shorter spine on 7. Ventrally, pale yellowish white, with lateral brown stripes, widest on sternites 8 and 9. A brown transverse band across the center of sternite 9 connects the two lateral stripes. Posterior margin of 9 brown; anterior margin narrowly brown at middle.

Gills—Pale greyish lavender. Tracheae prominently dark purple. Seventh gill with median trachea and short lateral fringes.

Tails—Yellow with greenish tinge. Alternate joinings narrowly darker. Near base, each joining with a circle of stout dark spines. Further out, spines only at pale joinings. No spines toward tip. Tails fringed with rather long hairs.

Stenonema carolina Bks.?

These two specimens are probably pale forms of *carolina* Bks., as is evidenced by the structure of the genitalia. I found one male at the Blue Ridge Assembly grounds on June 18, 1929. Another very similar specimen was captured by Prof. Needham at Mt. LeConte, Great Smoky National Park, on Aug. 14, 1929. Both males are paler than is typical for *carolina*, somewhat resembling members of the *pulchellum* subdivision. The Blue Ridge specimen has white tails. There are 5 costal cross veins before the bulla, 2 at the bulla, and 11 beyond. Veins brown in the entire forewing. The Mt. LeConte specimen does not have the typical brownish tinge on the costal border of the fore wing, and the veins are much paler in the posterior half of the wing. In both specimens, only two margined radial cross veins are present at the bulla. In both, the first fore tarsal joint is more than $\frac{1}{3}$ but less than $\frac{1}{2}$ the length of the second. Neither specimen has the dark posterior margins of the tergites continued on the sternites, to form continuous dark bands around the abdomen, as is the case in *carolina*. In other respects these males resemble *carolina*.

The body of the Blue Ridge specimen measures 9 mm.; wing 10 mm.; tails 25 mm. The LeConte specimen is slightly larger and stouter.

Stenonema ithaca Clem.

This species and *S. pudicum* Hag. were more common in the mountains than any other species of the genus. Nymphs of *ithaca* were collected

from many stations, and many imagoes were reared. The Carolina specimens are smaller than the spring and early summer nymphs near Ithaca, N. Y., and the imagoes lighter in color; but both nymphs and imagoes are very similar to the mid-summer forms from that locality. Collections were made during June and July of 1929 and 1930. Following is the list of localities from which this species was taken. North Fork of the Swannanoa River near Black Mountain; the Swannanoa River at Black Mountain, and its tributaries in the Blue Ridge Assembly grounds and another near Swannanoa; Flat Creek, another tributary of the Swannanoa; Pigeon River at Cruso; a small tributary of the Pigeon at Waynesville; Davidson River in the Pisgah National Forest; Cullasaja River south of Franklin; French Broad River near Rosman; a small stream near Fairview; Bald Creek west of Burnsville; Laurel River and its tributary near Hot Springs; Spring Creek near Hot Springs; Little River near Penrose; Little River at Cedar Mountain; Ocona Lufty River at Cherokee; Pacolet River at Tryon; Ivy River at Forks of Ivy; and South Toe River at Micaville.

Stenonema pudicum Hag.

Another species which was very abundant in the mountain region. Many nymphs were collected and several imagoes reared. This species was taken at each of the following localities. Pacolet River near Tryon; Little River at Cedar Mountain; a small stream at Waynesville; a tributary of the Pigeon River west of Hazelwood, and another tributary near Waynesville; Ocona Lufty River near Cherokee; Cedar Creek near Glenville; another tributary of the Tuckaseegee River near Glenville; a tributary of the Nantahala River near Wesser; a tributary of the Rocky Broad at Bat Cave, and another near Chimney Rock; Scott's Creek near Sylva; a tributary of the North Fork of the Catawba River near Woodlawn; the Catawba River at Andrews Geyser; Flat Creek at Black Mountain; a small tributary of the Tennessee River at Franklin; two small streams on Cowee Mountain, draining to the Tuckaseegee River; Cullasaja River south of Franklin; and Rock Creek, west of Brevard. They were perhaps most numerous at Cedar Creek near Glenville. Several imagoes were reared from nymphs taken in this stream.

As noted in recording this species from the piedmont, the nymphs and imagoes taken in that region differ somewhat from the mountain specimens, which I believe to be the true *pudicum*. The piedmont

specimens may be varieties, or may perhaps represent a different species. The imagoes from both regions have been contrasted (p. 189). Nymphal differences are noted here.

Nymph (from Cedar Creek)

Differs from nymphs described from the Cascades mainly in the ventral markings, which are much less extensive and less sharply defined in the mountain specimens. Structural features and other color markings are very similar in both forms.

Venter of abdomen reddish brown, darker on the apical segments, especially sternite 9. Rather indistinct brown lateral line the length of the venter, on each side. Oblique dark brown subventral dashes extend outward from the middle of the anterior margin, on each sternite, but the space between these dashes is not filled in solidly with brown, as in the Cascades nymph. Some nymphs show a faint indication of dark brown areas on each side of the midventral line, connected to the oblique dashes anteriorly, on sternite 8. A very dark brown patch occupies the postero-lateral angles of sternite 9, but is not extended into wide longitudinal bars on each side, as in the piedmont specimens. In some nymphs, the distal half of the tail is not barred.

Stenonema ruber McD.?

Nymphs which are apparently identical with those from the piedmont which I am calling *ruber* McD., were collected at two different localities in the mountain and male imagoes reared. The imago from Flat Creek at Black Mountain emerged on June 17, 1930. The other, from a small stream at Camp Carolina near Brevard, emerged July 23, 1930.

Stenonema exiguum, sp. nov.

A species close to *S. integer* McD. Tails unmarked, no stigmatic dots.

Male imago

Size—Body 5½ mm.; wings 6 mm.; tails 15 mm.

Head—Pale whitish, unmarked except for a faint reddish dot at center of vertex. Antennal filament dusky at base.

Thorax—Pale creamy white, unmarked.

Legs—Pale creamy white. Femora with median and apical rose-colored or lavender bands. Tibiae of second and third legs with rose-colored spot near basal end. On fore leg, tibiotarsal joint distinctly

purplish black; tarsal joinings narrowly dark. First tarsal joint slightly more than ½ as long as second. Claws and distal half of last tarsal joint, on all legs, distinctly dusky.

Wings—Hyaline, iridescent. Stigmatic area opaque, with pale but distinct red stain. Cross veins of fore wing prominent, very dark brown. Longitudinal veins on costal margin yellowish brown, remainder pale yellow. Humeral cross vein purplish black. About 4 costal cross veins before bulla, 8–9 beyond. Hind wing narrowly dark brown on outer apical margin. All veins colorless.

Abdomen—White. Segments 1–7 semi-hyaline, 8–10 opaque and washed with pale yellow. All tergites with narrow but distinct purplish black posterior margins. No stigmatic dots. Ventrally unmarked, but ganglionic areas distinctly opaque.

Tails—White; unmarked.

Genitalia—Very similar to *S. integer*. See Fig. 4.

Female imago (from Georgia specimen)

Similar to male, except for usual differences. Cross veins of fore wing relatively darker in color, and longitudinal veins paler, than in male. Body 5½–7 mm.; wings 7–8 mm.; tails 14–15 mm.

Holotype—Male imago. Caught in flight near Woodlawn, N. C., July 16, 1930. No. 1126.1 in C. U. collection.

Allotype—Female imago, Chattahoochee River, Atlanta, Ga., June 10, 1932. Collector, Prof. P. W. Fattig. No. 1126.2 in C. U. collection.

Paratypes—2 male imagoes, Etowah River, Rome, Ga., Aug. 16, 1931. Collector, Prof. P. W. Fattig. 22 females, Chattahoochee River, Atlanta, Ga., June 10, 1932. Prof. Fattig, collector. Nos. 1126.3–26 in C. U. collection.

The holotype, collected near Woodlawn, N. C., probably came from the Catawba River, which is not far distant. The allotype and paratypes, while collected in Georgia by Prof. Fattig during June and August, are so similar to the holotype that there seems no doubt but that they are of the same species. Descriptions and measurements of the male imago are drawn from the holotype.

Stenonema bellum, sp. nov.

Related to *integer* McD., but lacking the dark-bordered hind wing of that species. Oblique dark marks in place of stigmatic dots. A pale whitish species.

Male imago

Size—Body 6½ mm.; wing 7 mm., tails 14 mm.

Head—Pale whitish. A small black dot at inner lower corner of eye, opposite antenna. A narrow reddish line beneath each antenna. Antennae wholly pale. A V-shaped reddish mark on vertex between lateral ocelli. On each side of head near the posterior margin, a large dusky triangular spot.

Thorax—Creamy white. On each side of pronotum, a somewhat oblique purplish red streak, its posterior end continued laterally as a reddish line parallel to the hind margin of the segment. A black line in postero-lateral angle. Prominent oblique purplish black line on pleura of pronotum, extending down to coxa of fore leg. Black pencillings on pleura of meso- and metathorax, anterior and posterior to second and third legs, and extending up between them. Oblique purplish marks on each side of metanotum.

Legs—Pale yellowish white, femora distinctly washed with yellow. Median and apical purplish rose bands on all femora. Purplish rose streak near basal end of each tibia. Tibio-tarsal joining of fore leg faintly dusky. Claws pale brownish yellow.

Wings—Longitudinal veins of costal margin yellowish, all others pale. Cross veins of fore wing dark brown, paler along inner margin. Hind wing wholly pale, without dark outer margin; all veins pale.

Abdomen—Segments 1–7 white, semi-hyaline; 8–10 opaque, yellowish. All tergites narrowly purplish black on posterior margins. Oblique purplish black line near stigmatic region on each side of each tergite, extending forward from each end of the black posterior margin. A double (bifurcate) purplish streak on mid-dorsal line of tergites 3 and 6, in posterior ⅔ of these segments. Faint indications of such a streak on tergites 2 and 7, and a black median dot on posterior margin of tergite 4. Venter unmarked, but ganglionic areas opaque white.

Tails—White. Alternate joinings narrowly ringed with purplish black.

Genitalia—Pale yellowish. Quite similar to those of *exiguum* sp. nov. Forceps relatively longer, both in this species and in *exiguum*, than in *integer* McD.

Female imago

Size—Body 6½–7 mm.; wings 8 mm.; tails 12 mm.

Similar to male except as noted. A small black dot on each side of

median carina, connected to line beneath antenna in one specimen. Laterad of base of antenna, a very small black dot. Markings on vertex and occiput less extensive than in male. On abdominal tergites the black median streaks are wider than in the male. All longitudinal veins pale. Cross veins of costal to median spaces of fore wing pale brown, all others colorless.

Holotype—Male imago. Taken at auto lights, from French Broad River, Penrose, N. C., July 19, 1930. No. 1127.1 in Cornell University collection.
Allotype—Female imago. Same data. No. 1127.2 in C. U. collection.
Paratype—Female imago. Same data. No. 1127.3 in C. U. collection.

Stenonema sp. No. 3.

A species evidently related to *pudicum*, but with a very pale imago. Nymph has a distinctive color pattern. As only females were reared, the species is designated by number only.

Female imago

Size—Body 11 mm.; wing 11–12 mm.; tails 26 mm.
General color—Pale yellowish white.
Head—No markings on frons. Small orange spot at center of vertex, near posterior margin. Small dark mark at inner edge of each eye, near posterior margin.
Thorax—Entirely pale, except for narrow black markings above and in front of the base of the 2nd and 3rd leg, and another above the base of the fore leg.
Legs—Pale creamy white. Indistinct median and apical purplish bands on femora, the median band very faint on the third leg. Apex of tibia, and all tarsal joinings narrowly dark reddish brown. Last tarsal joint dusky.
Wings—Humeral cross vein quite heavily infuscated. Slight crowding of subcostal and radial cross veins at bulla. Stigmatic area opaque white. Longitudinal veins of costal margin yellow; all others pale yellowish brown. Cross veins reddish brown, very distinct and much thicker than the longitudinals. Those of the basal half narrowly infuscated. Cross veins numerous. Usually 5 costals before bulla, and 14–17 beyond. Hind wing rather widely stained with brown on apical portion of outer margin. Veins pale except along costal and apical margins.

Abdomen—Segments 1–8 semi-hyaline, pale creamy white. Segments 9 and 10 opaque, tinged with yellow. Eggs, when present, give yellow tinge to abdomen. Each tergite with rather broad purplish brown posterior margin. Stigmatic dots present on 3–6. Venter pale, unmarked. Subanal plate broad, with a broad shallow emargination on its apical margin.

Tails—White. Joinings narrowly dark purplish brown.

Nymph

Size—Body 11–12 mm.; tails 19 mm.

General color—Reddish brown, paler ventrally.

Head—Reddish brown. Pale marks anterior to median ocellus and laterad of lateral ocelli. A narrow pale strip from outer anterior margin of eye to lateral border. Postero-lateral angles yellowish.

Thorax—Lateral borders of pronotum pale. A round light spot near center of each side; another at anterior margin on each side of median line; a third paler spot near posterior margin on each side of median line. A rather large pale oblong mark on each side of mesonotum, between median line and wing roots. On each side of this, toward the wing roots, a smaller light spot.

Legs—Femur reddish brown with a median pale transverse band; also pale areas at each end on the hind margin, and basally on the front margin. A small light dot near center in basal half of each femur. Tibia pale, with basal dark brown band and another between middle and apex. Tarsi dark reddish brown except for a narrow pale basal area. Claws pale, tipped with amber. Without pectinations.

Abdomen—Postero-lateral spines on 5–9. Short on 5 and 6. Those on 7 and 9 somewhat longer, and about equal in length. Spine on 8 longest. Reddish brown dorsally, paler on lateral margins of gill-bearing segments. Tergites 1–3, and 9 and 10, largely reddish brown; 10 usually pale along anterior margin, and 9 may have indistinct pale submedian streaks. Tergite 6 reddish brown with pale oblique submedian marks from the anterior margin. Tergites 4 and 5, and 7 and 8, each with a distinctive white V-shaped mark at median line. Point of V is on or near the posterior margin at the median line. Its arms diverge and extend forward on each side of the median line to the anterior margin, becoming somewhat wider anteriorly. In 4 and 5, the anterior end of each arm of the V is extended laterally as a short white transverse mark parallel to the anterior margin. On tergites 5 and 8, the point of the V may be obsolete. Ventrally yellowish to pale yellowish brown.

Sternite 9 may be shaded with brown on the lateral margins. Gills dark purplish grey.

Tails—Greenish yellow tinged with brown. Stout spines encircle the joinings in the basal half, being stouter at alternate joinings except very near the base. In distal half, where the segments are longer than at the base, each segment is crossed by a white transverse band at about the middle of its length.

Five females of this species were reared. Three of these are from nymphs taken in a small stream on Cowee Mountain, between Dillsboro and Franklin. These females transformed on July 8 and 12, 1929. Another is from Franklin, on July 10, 1929, while the fifth, from a small stream near Swannanoa, transformed June 15, 1930.

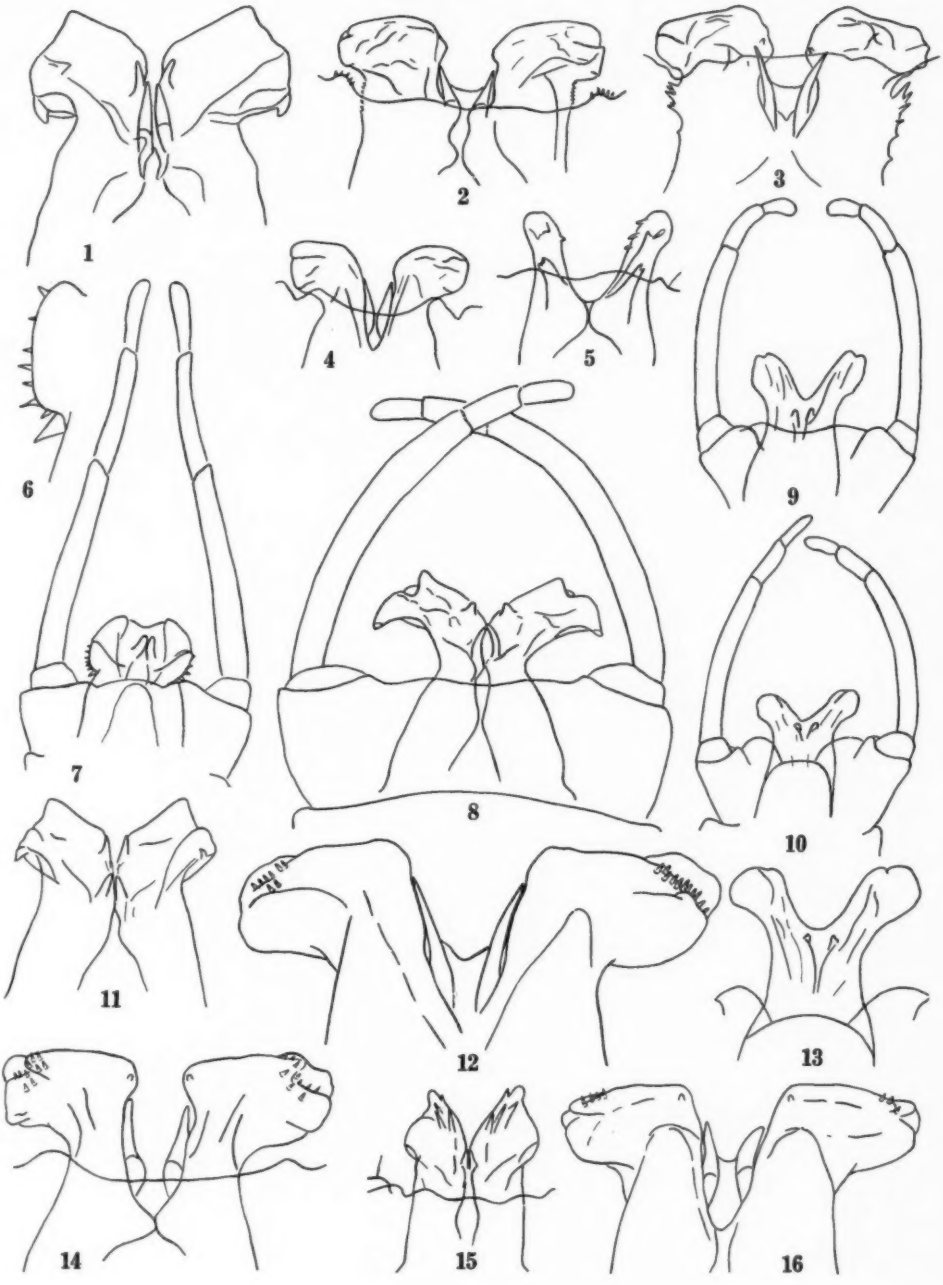
Nymphs were likewise collected, during June and early July of the summers of 1929 and 1930, from Black Mountain; the Little River at Cedar Mountain; the Catawba River near Andrews Geyser; and a little stream near Balsam. Immature nymphs were taken by Prof. Needham near Stump House Mountain, S. C., and Highlands, N. C., on April 5, 1929. A spent female was caught in flight a few miles west of Selica, near an old mill, on July 13, 1930.

CORNELL UNIVERSITY,
ITHACA, N. Y.

EXPLANATION OF PLATE 15

Fig. 1. *Heptagenia pulla* Clem. Details of penes. (Genitalia of *elegantula* type.)
Fig. 2. *Stenonema carolina* Bks. Details of penes.
Fig. 3. *Stenonema interpunctatum* Say. Details of penes. (From Goshen Swamp specimen.)
Fig. 4. *Stenonema exiguum*, sp. nov. Details of penes. (Genitalia of *terminatum* type.)
Fig. 5. *Rhithrogena fasciata*, sp. nov. Details of penes.
Fig. 6. *Heptagenia spinosa*, sp. nov. Details of one side of penes.
Fig. 7. *Heptagenia spinosa*. Genitalia.
Fig. 8. *Heptagenia marginalis* Bks. Genitalia. (Genitalia of the *flavescens* type.)
Fig. 9. *Iron rubidus*, sp. nov. Genitalia.
Fig. 10. *Iron dispar*, sp. nov. Genitalia.
Fig. 11. *Heptagenia julia*, sp. nov. Details of penes.
Fig. 12. *Stenonema pudicum* Hag. Details of penes.
Fig. 13. *Iron dispar*. Details of penes.
Fig. 14. *Stenonema tripunctatum* Bks. Details of penes.
Fig. 15. *Heptagenia aphrodite* McD. Details of penes. (Genitalia of *maculipennis* type.)
Fig. 16. *Stenonema annexum*, sp. nov. Details of penes. (Genitalia of *pulchellum* type.)

PLATE 15



ALGAE OF CHARLOTTESVILLE AND VICINITY

By Ivey F. Lewis, Conway Zirkle, and Ruth Patrick

Plate 16

Charlottesville is located in the piedmont section of Virginia at an elevation of from five to six hundred feet above sea level. It is fairly well watered, having an average annual precipitation of about 46 inches, and being in a region of rolling hills and low mountains is very well drained. There are no ponds or lakes except artificial ones in the region in which the collections were made nor are there any bogs or swamps over a quarter of an acre in extent.

The water in all the small streams and in the Rivanna River is soft and contains a great deal of iron. The city itself is located on the dividing line of two geological regions, the Cambrian and the Algonkian. Most of the collections were made in the former, where the majority of small streams are located. The only collections made in the Algonkian were along the river banks and the larger streams.

The collections were confined to a radius of approximately three miles about the city limits except for the city reservoir six miles to the west and the stream which flows from it. The algal flora is abundant throughout the year. Ninety genera and 249 species were identified, and there were also found a number of species represented by specimens too fragmentary to allow of identification. Four new species are described. The relative number of genera and species in the various groups is as follows:

GROUP	NO. OF GENERA	NO. OF SPECIES	NO. OF VARIETIES
Myxophyceae	22	57	
Chlorophyceae (except desmids)	45	71	1
Desmidiaceae	17	115	14
Heterokontae	4	5	
Rhodophyceae	2	1*	
Total	90	249	15

* (One not identified).

The Conjugales are exceptionally abundant and varied, often as many as 25 species appearing in a single collecting vial. Abundant as they are, however, conjugation is extremely rare, only three instances having been found in a period of seven years.

All except two species identified were preserved either in formalin or on glycerin-jelly or Karo slides and indexed for reference. Camera lucida drawings were made of these two specimens and their identification was checked repeatedly.

The work in 1930–31 was based in part on collections made as usual and in part on studies of the intestinal contents of tadpoles. Miss Farlow[1] found that the algae contained in the alimentary tracts of tadpoles were of many different species, and from this source a good representation of the flora of a pond can be obtained. She used samples from different parts of the alimentary canal. This use of tadpoles as collectors has been found to be a very efficient one, but many more species are obtained if the complete tract rather than portions of it is used. Farlow suggests that the anterior part of the alimentary canal is the best for collecting purposes. This has been found true for filamentous forms, but desmids are distributed throughout the canal and diatoms are especially abundant in the posterior part. During this study both spring and fall collections were made. About 500 slides were made from tadpoles.

One of the most interesting results of this study is the finding of some very long Closteria. A great many specimens were found in the tadpole material whose existence in the ponds was not at first suspected. The long Closteria represent two species whose affinities seem to be with *C. lineatum* and *C. pritchardianum*, though with certain resemblances also to *C. juncidum* and *C. areolatum*. Descriptions will be found at the end of the annotated list of species.

Two species seem to be reported for the first time for the United States. They are *Cosmarium Lundellii* Delp. var. *ellipticum* West, found in Scotland and Wales, and *C. moniliforme* var. *panduriformis* Heimerl., found in Great Britain, Austria, and Australia.

ANNOTATED LIST OF ALGAE (EXCLUDING DIATOMS)

Myxophyceae

Anabaena catenula (Kuetz.) Bornet & Flahault
Small swamp by Fry Spring road; all seasons; common.

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[1] Farlow, C. V. Biological Bulletin 55 (6): 443–448. December, 1928.

A. inaequalis (Kuetz.) Bornet & Flahault
Small swamp on stream leading from city reservoir; spring; common.
A. irregularis sp. nov.
Old reservoir (see p. 221).
A. oscillarioides Bory
Temporary swamp below abandoned rock quarry on Observatory Mountain; May; rare.
A. variabilis Kuetz.
Swamp in cow pasture below University golf links; March; rare.
Aphanocapsa elachista W. & G. S. West
Filtered from city water supply; October; rare.
Calothrix epiphytica W. & G. S. West
Epiphytic on *Tolypothrix* from city reservoir; late autumn; rare.
C. parietina (Naegeli) Thuret
Swamp above University ice pond; early spring; rare.
Chamaesiphon curvatus Nords.
Still House Mountain stream; March; rare.
Chroococcus minor (Kuetz.) Naegeli
Growing on damp bank of Rivanna River; September to May; common.
C. varius A. Braun
On damp bank near steps of Cabell Hall; September; common.
Clathrocystis aeruginosa (Kuetz.) Henfrey
Swamp by golf links; October; rare.
Cylindrospermum catenatum Ralfs
Swamp in abandoned rock quarry on Observatory Mountain; September; common.
C. majus Kuetz.
On banks of the Rivanna River above the woolen mills; October; common.
C. minutissimum Collins
Swamp on stream from old University reservoir; November; common.
C. minutum Wood
Stream crossing Fry Spring road; November; common.
C. muscicola Kuetz.
Swamp in orchard below University cemetery; December; common.
Gloeocapsa conglomerata Kuetz.
Shaded terrace by west door of Cabell Hall; December; common.
Gomphosphaeria aponina Kuetz.
Swamp in orchard below University cemetery; February; rare.
Hapalosiphon flexuosus Borzi
On bank of University ice pond; February; rare.
Lyngbya aerugineo-caerulea (Kuetz.) Gomont
On the banks of the Rivanna River above the woolen mills; October to May; common.
L. arachnoidea Kuetz.
Stream by Southern freight yards; November; rare.
L. Digueti Gomont
Stagnant pond in University sunken garden; April; rare.

L. gigantea sp. nov.
Swamp by Garth road; March; rare (see p. 221).
L. Martensiania Menegh.
Growing on the damp bank north of Cabell Hall; September to December; common.
L. nana Tilden
Swamp north of the road to the city reservoir; November; rare.
L. spirulinoides Gomont
Small stream by the abandoned rock quarry; November; rare.
L. versicolor (Wartman) Gomont
Swamp in orchard back of University cemetery; March; rare.
Merismopedium aerugineum Bréb.
Swamp in the abandoned rock quarry, strained from top water; September to June; common.
Microcoleus paludosus (Kuetz.) Gomont
Swamp north of golf links; September to December; rare.
M. vaginatus (Vaucher) Gomont
Near steps of Cabell Hall; on soil in open woods; November; common.
Nodularia Harveyana (Thwaites) Thuret
Swamp in abandoned rock quarry; October; rare.
Nostoc commune Vaucher
Near steps of Cabell Hall on north terrace; September; common.
N. cuticulare (Bréb.) Bornet & Flahault
City reservoir, epiphytic on *Nitella*; late autumn; rare.
N. gelatinosum Schousb.
Found growing symbiotically with *Anthoceros* on the road to Monticello; September; rare.
Oscillatoria Boryana Bory
Stream through the barbecue grounds; September; rare.
O. chalybea Mert.
Found in overflow of the old reservoir; April; rare.
O. chlorina Kuetz.
Growing in cistern north of Randall Building; October; rare.
O. limosa Ag.
Found in nearly all small streams about Charlottesville; September to April; very common.
O. princeps Vaucher
Found in gutter along Scottsville road; November to February; fairly common.
O. sancta Kuetz.
In stream along Fry Spring road; February; rare.
O. splendida Grev.
Growing in an old aquarium; January; rare.
O. tenuis Ag.
On mud bank of Rivanna River, exposed during low water; October; rare.
Phormidium corium (Ag.) Gomont
Stagnant pond in University sunken garden; March; rare.

P. foveolarum (Mont.) Gomont
Found in overflow from old reservoir; April; rare.
P. rubrum Tilden
On edge of stream along Fry Spring road; October; rare.
P. subuliforme Gomont
Stream by Southern freight yards; November; rare.
P. valderianum (Delp.) Gomont
Found in overflow of reservoir; April; rare.
Scytonema Hofmanni Agardh
In recently drained portion of Davis Pond; September; rare.
S. Austinii Wood
Under overhanging cliffs of James River; all seasons; rare.
Stigonema minutum (Ag.) Hassall
In Davis Pond; September; rare.
Symploca muralis Kuetz.
On mud bank of Rivanna River; on ground in open woods; all seasons; common.
Synechococcus aeruginosus Naegeli
Swamps in cornfield below University cemetery; March; rare.
Tolypothrix distorta (Hofman-Bang) Kuetz.
Small stream from Kearney's Mountain; March; rare.
T. lanata Wartmann
Old reservoir; September to December, March to May; common.
T. rupestris Wolle
Moist bank on road to Monticello; October; rare.
T. tenuis Kuetz.
Swamp in orchard below University cemetery; November to March; rare.

Chlorophyceae and Conjugales (Except Desmids)

Ankistrodesmus Braunii (Naegeli) Brunn.
Small streams below Davis Pond; November; rare.
A. falcatus (Corda) Ralfs
Filtered from water of old reservoir; March; rare.
Bulbochaete sp.
In the old reservoir; September to June; very common. As in no instance was fruiting observed a specific identification was impossible.
Chaetophora pisiformis (Roth) Agardh
Stream by abandoned rock quarry; May; fairly common.
Characium sp.
On brown *Hydra*; October; rare.
C. gracilipes Lambert
On Daphnia, pond by Lynchburg road; October; rare.
Chlamydomonas communis Snow
In small temporary spring by golf links, in swamp south of road to city reservoir; September to June; very common.
C. stellata Dill.
Old reservoir; September to December; fairly common.
Chlorococcum humicola (Naeg.) Rabenhorst
Swamp by small stream crossing Fry Spring road; October; common.

C. infusionum (Schrank) Meneghini
Pond on Lynchburg road, two miles south of Charlottesville; February; rare.
Chlorogonium euchlorum Ehrenberg
Swamp by Garth road; April; common.
Cladophora sp.
Growing in old aquarium; January; very rare, not enough found to identify.
Coleochaete divergens Pringsheim
Mixed with *Batrachospermum* in small stream from Kearney's Mountain; March; rare.
C. Nitellarum Jost
Growing endophytically in the cell wall of *Nitella*; November; rare.
C. scutata Bréb.
Old reservoir; September to December, March to June; fairly common.
Crucigenea truncata G. M. Smith
In tap water; March; abundant.
Cylindrocapsa conferta W. West
Swamps by golf links; April; rare.
Dictyosphaerium pulchellum Wood
Swamps below barracks; March; rare.
D. Ehrenbergianum Naegeli
Old reservoir, Sinclair's pond; October; rare.
Draparnaldia glomerata (Vauch.) Agardh
In nearly all small streams, Sinclair's ice pond; September to June; very common.
Eremosphaera viridis De Bary var. *major* Moore
Found in small swamp below University ice pond; October to May; common. Some specimens were as large as 210 microns in diameter. However it is evidently not a new variety as transitional sizes were found between the type form and the largest form.
Eudorina elegans Ehrenberg
Tap water, old reservoir; September to May; never abundant.
Gloeococcus Schroeteri (Chodat) Lemmermann
Swamp below Histological Laboratory; February; rare.
Gloeocystis gigas (Kuetz.) Lagerheim
Swamp in abandoned rock quarry; October; common.
G. planctonica Lemmermann
Pool in University sunken garden; March; rare.
Kirchneriella lunaris (Kirchner) Möbius
Found in old aquarium; May; rare.
K. obesa (W. West) Schmidle
Found in an old aquarium; common in collections of desmids; September to June; common.
Microspora Loefgrenii (Nordst.) Lagerheim
In small stream on the road to the city reservoir; February; rare.
M. Lauterborni Schmidle
Swamp in upper end of University ice pond; March; rare.
M. Willeana Lagerheim
In wet weather spring north of golf links; September to July; common.

Microthamnion strictissimum Rabenhorst
In wet weather spring north of golf links; May; rare.

Mougeotia sp.
Swamp by golf links, old reservoir, Moore's Creek; year round; common. At least three species, but was never found conjugating and consequently no identification was possible.

Nephrocytium obesum West
Tap water; February; rare.

Nitella sp.
City reservoir; year round; abundant.

Nitella sp.
Old reservoir, Chamberlain pool; common.

Oedocladium albemarlensis Lewis
On bank of Rivanna River; September to October; rare.

Oedogonium crenulato-costatum Wittrock
City reservoir growing on *Nitella*; November; rare.

O. grande Kuetz. forma *robusta*
University lagoon; October; rare.

O. mexicanum Wittrock
Old reservoir; October; rare.

O. plagiostomum var. *gracilius* Wittrock
Fish pond on Lynchburg road; September; rare.

O. Reinschii Roy
Old reservoir; October; fairly common.

O. rufescens Wittrock
Old reservoir; October; rare.

Oocystis Borgei Snow
Swamp north of golf links; March; rare.

O. crassa Wittrock
Tap water; September to December; common.

Pandorina morum (Muell.) Bory
In tap water; September to March; common.

Protococcus viridis Ag.
On north side of trees on University grounds; year round; common. A larger form was also found growing on cistern north of the Randall Building. The cells measured 8–11 μ by 10–14 μ. As the genus is at present in such a confused state no new variety was made.

Protosiphon botryoides (Kuetz.) Klebs
Growing on moist banks near door of Cabell Hall; September; rare.

Radiofilum irregulare (Wille) Brunnthaler
Swamp south of golf links; March to June; common.

Scenedesmus arcuatus Lemm. var. *platydisca* G. M. Smith
Old reservoir, Chamberlain and Sinclair's ponds; September to June; common.

S. bijuga (Turp.) Wittrock
Tap water; December; rare.

S. brasiliensis Bohlin
Old reservoir, Sinclair's pond; September to May; fairly common.

S. quadricauda (Turp.) Bréb.
In most collections of desmids, almost pure in fish aquarium; September to July; common.
S. serratus (Corda) Bohlin
Old reservoir; October to December; rare.
Schizochlamys delicatula West
Swamp on Scottsville road; April; rare.
Schizomeris Leibleinii Kuetz.
Stream crossing Fry Spring road, Rivanna River near Milton; October; rare.
Selenastrum gracile Reinsch
Growing in an old aquarium; September; rare.
Sorastrum bidentatum Reinsch
In Davis Pond; September; rare.
Sphaerella lacustris Hazen
Fry Spring; throughout the year; common.
Spirogyra spp.
At least a dozen species of *Spirogyra* have been found ranging in diameter from 7 microns to 145 microns. They are very abundant, occurring in all of the small streams and ponds. Only two instances of conjugation have been observed in a search of seven years. Collections were made during every month of the year.
S. inflata (Vauch.) Kütz
Pond by Lynchburg road; May; rare in fruit.
Spirogyra longata (Vauch.) Kuetz.
Swamp by Garth road; July; rare.
Stichococcus bacillaris Naegeli
In hydrant north of the Randall Building; October; rare.
S. fluitans Gay
In stream by abandoned rock quarry; March; fairly common.
Stigeoclonium lubricum (Dillw.) Kuetz.
Still House Mountain stream; May; rare.
S. nanum (Dillw.) Kuetz.
Small stream emptying into Rivanna River above Free Bridge; April; rare.
S. stagnatile (Hazen) Collins
In temporary spring north of golf links, growing attached to washed out roots; also floating in old reservoir. Collins records this species occurring floating but has no record of its growing attached. November; rare.
S. subsecundum Kuetz.
Growing on small stones in the creek back of the old amphitheatre; September; rare.
S. variabile Naegeli var. *Fritschianum.*
In spring above Southern freight yards; March; very abundant.
S. variabile Naegeli var. *Gayanum.*
In spring above Southern freight yards; March; very common. This variety was mixed with the preceding one. They may be forms of the same variety.
Tetraspora lubrica (Roth) Agardh
In small spring on barbecue grounds, in streams; May; common.
Trentepohlia sp.
On cliff above Rivanna and Moorman's Rivers; all seasons; locally abundant.
Ulothrix variabilis Kuetz.
Stream by golf links; September to June; common.

Vaucheria geminata (Vauch.) De Candolle
Stream by golf links; on moist soil; spring and fall; common.
V. orthocarpa Reinsch
Stream by rock quarry; July; rare.
V. repens Hassall
Growing in well shaded swamp up stream from abandoned rock quarry; April; very common.
V. sessilis (Vauch.) De Candolle
Stream by golf links; spring; common.
Zoochlorella conductrix Brandt
Found in cells of *Hydra*; common at all seasons.
Z. parasitica Brandt
In *Spongilla* and various protozoa; common at all seasons.
Zygnema insigne (Hass.) Kuetz.
In most of the small streams; the year round; very common. Several other species have been found but could not be identified for lack of zygospores.

Desmidiaceae

Arthrodesmus triangularis Lagerh. forma *triquetra* W. and G. S. West
In small swamp by stream leading from city reservoir; November; rare.
Closterium abruptum West
Hog wallow on Duke farm; March; common.
C. acerosum (Schrank) Ehrenberg
Swamp in abandoned rock quarry; October; common.
C. acerosum var. *elongatum* Bréb.
Swamp in abandoned rock quarry; October; common. Some specimens as long as 850 μ.
C. Cornu Ehrenberg
Tap water; September; rare.
C. decorum Bréb.
Swamp north of golf links; late autumn; common.
C. didymotocum Corda.
Old reservoir, Chamberlain's pond, Sinclair's pond; September to May; common.
C. fulvum sp. nov.
Old reservoir; September to December; common (see p. 222).
C. gracile Bréb.
Swamp north of golf links; early spring; common.
C. intermedium Ralfs
Swamp in orchard below University cemetery, old reservoir; fall and early spring; common. Some specimens were found which were 600 μ long.
C. lanceolatum Kuetz.
Pool in sunken garden; November; rare.
C. Leibleinii Kuetz.
University ice pond; February; rare.
C. lineatum Ehrenberg
Swamp north of golf links; September to March; common. This species varies greatly in length, being from 290–870 μ long.

C. Lunula (Müll.) Nitzsch
Swamp in abandoned rock quarry; October; common.
C. Lunula var. *intermedium* Gutw.
Swamp in abandoned rock quarry; November; rare.
C. moniliferum (Bory) Ehrenberg
In pond below cemetery; November; common.
C. parvulum Naegeli
University ice pond; March; rare.
C. Ralfsii Bréb. var. *hybridum* Rabenh.
Swamp in upper end of ice pond; March; common.
C. ranunculi sp. nov.
Old reservoir; September to December; common (see p. 222).
C. striolatum Ehrenberg
Davis Pond; October; rare.
C. subulatum (Kuetz.) Bréb. var.
Our specimens differ from the described species in number of pyrenoids and also in general shape. Both margins of the specimens are slightly tumid and not curved as described. Many of the specimens found here are slightly sigmoid. Old reservoir; autumn collections; fairly common.
C. toxon West
Swamp north of golf links; October; rare.
C. turgidum Ehrenberg
Swamp in abandoned rock quarry; September; common.
C. Venus Kuetz.
Old reservoir; fall collections; fairly common.
Cosmarium angulosum Bréb.
Swamp in orchard below University cemetery; November; common.
C. alpestre Roy and Biss.
This species has been recorded from only two other places; by Roy and Bissett from Scotland and by Brown from Lake Ronkonkoma, New York. West states he has never found it. Our specimens are slightly smaller than those described by Roy and Bissett.
C. caelatum (Ralfs) var. *spectabile* (De Not.) Nordst.
Swamp north of golf links; March; fairly common.
C. circulare (Reinsch) forma *minor* West
Swamp in abandoned rock quarry; September; rare.
C. connatum Bréb.
Swamp in abandoned rock quarry; September to December; common.
C. contractum (Kirch.) var. *ellipsoideum* (Elfr.) West
Swamp in abandoned rock quarry; September; rare. This form is a trifle smaller than the measurements given by West, being 26 μ long by 20 μ wide.
C. cyclicum Lund.
Spring up stream from Southern freight yards; May; rare.
C. cylindricum Ralfs
Swamp in abandoned rock quarry; October to February; common.
C. dentatum Wolle
University ice pond; February to April; common.
C. exiguum Arch. var. *subrectangulum* West
University ice pond; March; rare.

C. globosum (Bulnh.) forma *minor* Boldt
Swamp in abandoned rock quarry; November; rare.
C. granatum Bréb.
Swamp in abandoned rock quarry; October to December; common.
C. Hammeri Reinsch. var. *homalodermum* (Nordst.) West
Swamp north of golf links; November; common.
C. Hammeri var. *protuberans* W. and G. S. West
Swamp in abandoned rock quarry; November; common.
C. Holmiense Lund.
Swamp up stream from Southern freight yards; May; rare.
C. isthmium (West) var. *hibernicae* West
Swamp in orchard below cemetery; October to December; common.
C. jenisejense Boldt
Swamp on Still House Mountain stream; March; rare.
C. Lundelli Delp. var. *ellipticum* West
Old reservoir; September to December; rare.
C. margaritatum (Lund). Roy and Biss.
Swamp north of golf links; April; rare.
C. Meneghinii Bréb. forma *latiuscula* Jacobs
Swamp on Scottsville road two miles south of Charlottesville; November to March; common.
C. microsphinctum Nordst.
Swamp north of golf links; November; rare. The specimens were a little larger than the type measurements given by West, being 50 μ by 22 μ.
C. microsphinctum var. *parvula* Wille
Tap water; October; rare.
C. moniliforme (Turp.) Ralfs
Tap water; September; rare.
C. moniliforme var. *panduriformis* Heimerl.
Old reservoir; October; rather rare.
C. Naegelianum Bréb.
Swamp in abandoned rock quarry; October; rare.
C. nitidulum De Not.
Swamp north of golf links; September; rare.
C. obtusatum Schmidle
In ditch beside Scottsville road; May; rare.
C. ovale Ralfs
Swamp north of golf links; year round; very common.
C. pachydermum Lund.
Marsh east of University ice pond; December; rare.
C. Portianum Arch.
Swamp in abandoned rock quarry; October to December; common.
C. sexangulare Lund.
Old reservoir; September to November; rare.
C. subcucumis Schmidle
Pool by golf links; September to May; common.
C. subundulatum Wille
Swamp south of road to city reservoir; April; rare.

C. tetragonum (Naeg.) Arch.
Swamp on Scottsville road, two miles south of Charlottesville; April; rare.
C. Turpinii Bréb.
Swamp in abandoned rock quarry; October to December; common.
C. viride (Corda) Josh.
Swamp near old Fair Grounds; March; rare.
C. undulatum Corda var. *minutum* Wittrock
Swamp north of golf links; February; rare.
Desmidium Aptogonum Bréb.
All along stream by golf links; the entire year; very abundant.
D. Baileyii (Ralfs) De Bary
Sinclair's pond, Chamberlain's pond, old reservoir; the entire year; abundant.
D. cylindricum Grev.
Swamp by Garth road; March; abundant.
D. Swartzii Ag.
Old reservoir; April to October; common.
Euastrum ampullaceum Ralfs
Swamp north of golf links; year round; common.
E. ansatum (Ralfs) var. *pyxidatum* Delp.
Swamp south of road to city reservoir; March; rare.
E. bidentatum Naeg.
Ditch beside Scottsville road two miles south of Charlottesville; April; rare.
E. crassum (Bréb.) Kuetz.
Along stream from old reservoir; at all seasons; very common.
E. denticulatum (Kirch.) Gay
Marsh east of University ice pond; March; rare.
E. Didelta (Turp.) Ralfs
In most swamps; September to June; very common. The form found here is sometimes a trifle smaller than the type, measuring 110–140μ long by 60–70μ wide.
E. dubium Naeg. var. *anglicanum* (Turn.) West
Swamp in abandoned rock quarry; November; rare.
E. gemmatum Bréb.
Ditch on side of the Scottsville road; May; rare.
E. insulare (Wittrock) Roy
Swamp in abandoned rock quarry; September; rare.
E. oblongum (Grev.) Ralfs
Swamp in orchard below University cemetery; at all seasons; very common.
E. verrucosum Ehrenberg var. *alatum* Wolle
Swamp in abandoned rock quarry; at all seasons; common.
Gonatozygon Brebissonii De Bary var. *laeve* (Hilse) W. and G. S. West
Stream by golf links; November; rare.
Hyalotheca dissiliens (Smith) Bréb.
In swamp north of golf links; at all seasons; very abundant.
Mesotaenium De Greyi Turn.
Small stream from Kearney's Mountain; March; fairly common.
Micrasterias americana (Ehrenberg) Ralfs
Marsh east of University ice pond; September to May; common.

M. americana var. *Boldtii* Gutw.
Tap water; October; rare.
M. americana var. *Lewisiana* West
Swamp on Scottsville road; October; rare.
M. Crux-Melitensis (Ehrenberg) Hass.
Swamp east of University ice pond; September to May; common.
M. denticulata (Bréb.) var. *angulosa* (Hantzsch.) West
In swamp north of golf links; at all seasons; common.
M. Jenneri Ralfs
In swamp north of golf links; at all seasons; common.
M. laticeps Nordst.
Tap water; throughout the year; common.
M. papillifera Bréb.
In swamp in abandoned rock quarry; September to June; common.
M. papillifera var. *glabra* Nordst.
Swamp on Scottsville road; May; rare.
M. pinnatifida (Kuetz.) Ralfs
In swamp in abandoned rock quarry; October to December; common.
M. radiata Hass.
In swamp east of University ice pond; March to May; common.
M. rotata (Grev.) Ralfs
In swamp north of golf links; at all seasons; common.
M. truncata (Corda) Bréb.
In swamps in orchard below cemetery; November to June; common.
Netrium digitus (Ehrenberg) Itzigs. and Rothe
Found in all collections of desmids; at all seasons; very common.
N. digitus var. *constrictum* West
Old reservoir; fall collections; rare.
Penium Cylindrus (Ehrenberg) Bréb.
Small swamp on stream by Fry Spring road; February; rare.
P. Libellula (Focke) Nordst. [*Closterium Libellula* Focke]
Pool below cemetery; at all seasons; common.
P. Libellula var. *interruptum* West
Stream crossing Fry Spring road; April; common.
P. margaritaceum (Ehrenberg) Bréb.
Swamp in abandoned rock quarry; at all seasons; very common.
P. Navicula Bréb.
Old reservoir; fall collections; fairly common.
P. spinospermum Josh.
Swamp in orchard below University cemetery; November; rare.
Pleurotaenium coronatum (Bréb.) Rabenh.
Rock quarry; October; rare.
P. Trabecula (Ehrenberg) Naeg.
Swamp in abandoned rock quarry; at all seasons; very common.
Sphaerozosma Aubertianum West var. *Archeri* (Gutw.) W. and G. S. West
Small swamp on Still House Mountain stream; January; rare.
Spirotaenia bispiralis West
Swamp in abandoned rock quarry; September; rare.

S. condensata Bréb.
Swamp in abandoned rock quarry; September to December; common.
S. obscura Ralfs
Swamp on stream crossing Fry Spring road; September to May; common.
Staurastrum alternans Bréb.
Swamp north of golf links; March; rare.
S. alternans var. *pulchrum* Wille
Ditch on side of Scottsville road; April; rare.
S. Arctiscon (Ehrenberg) Lund.
Tap water; September; rare.
S. crenulatum (Naeg.) Delp.
Swamp north of golf links; February; rare.
S. cyrtocerum Bréb.
Swamp in abandoned rock quarry; at all seasons; common.
S. dejectum Bréb.
Marsh east of University ice pond; May; rare.
S. echinatum Bréb.
Temporary swamp below rock quarry; February; rare.
S. furcigerum Bréb. var. *eustephana* (Ehrenberg) Nordst.
Swamp in abandoned rock quarry; October to December; common.
S. gracile Ralfs var. *nanum* Wille
Tap water; October to January; fairly common.
S. lanceolatum Arch.
Davis Pond; October; rare.
S. muricatum Bréb.
Stream from Observatory Mountain; November; rare.
S. orbiculare Ralfs var. *depressum* Roy & Biss.
Swamp in abandoned rock quarry; October; rare.
S. orbiculare var. *extensum* Nordst.
Swamp in abandoned rock quarry; October; rare.
S. orbiculare var. *Ralfsii* W. and G. S. West
Swamp in east end of University ice pond; March; rare.
S. paradoxum Meyen
Tap water; September to January; common.
S. Saxonicum Bulnh.
Swamp on Scottsville road; April, rare.
S. sexangulare (Bulnh.) Lund.
Swamp in abandoned rock quarry; October; rare.
S. spongiosum Bréb.
Stream from Observatory Mountain; November; rare.
S. spongiosum var. *Griffithsianum* (Naeg.) Lagerh.
Swamp in orchard below cemetery; November; rare.
S. hexacerum (Ehrenberg) Wittrock
Swamp in orchard below University cemetery; December; rare.
Tetmemorus granulatus (Bréb.) Ralfs
Swamp north of golf links; February; rare.
Xanthidium antilopaeum (Bréb.) Kuetz.
Swamp on Scottsville road; March; rare.

Heterokontae

Botrydium granulatum (L.) Grev.
On mud bank of the Rivanna River above the woolen mills; September to December; common.

Botryococcus Braunii Kuetz.
Filtered from tap water; September to May; common.

Ophiocytium gracilipes (A.Br.) Rabenhorst
Growing attached to some old *Oedogonium* from stream from Still House Mountain; March; rare.

Tribonema bombycinum Derbes & Solier
Swamp north of golf links; November to March; common.

T. minus G. S. West
On backwater of Rivanna River above Free Bridge; November to April; very common.

Rhodophyceae

Batrachospermum moniliforme Roth
In nearly all the small streams about the University; February to April; very common.

Lemanea sp.
In the rapids of the outlet stream of the city reservoir; March; very rare. Observed once, not in identifiable condition.

NEW SPECIES

Anabaena irregularis sp. nov. Plate 16. Figs. 8, 9, 10.

Filaments pale blue-green, separate, free-floating, sheaths often not present; trichomes straight or slightly curved, 3–6 μ in diameter; cells different in shape, some cylindrical scarcely constricted at the joints, 3 μ in diameter, 5–9 μ long; others barrel-shaped or oblate spheroidal, 6 μ in diameter, 4–5 μ long; heterocysts spherical or slightly oblong, 4–7 μ in diameter, 7 μ long; gonidia single, remote from heterocysts, cylindrical, 9–12 μ wide, 12–20 μ long; wall of gonidium smooth.

From water oozing through the brick dam of the old University reservoir.

Lyngbya gigantea sp. nov. Plate 16. Fig. 7.

Filaments solitary and scattered; sheaths close, colorless, smooth throughout, 1–5 μ thick; trichomes 48–60 μ wide, straight, not constricted at the joints; apex of trichomes not tapering; apical cell rotund; calyptra none; cells 6–8 μ long, transverse walls not granulated; cell contents finely granular; pale olive to brown.

In swamp by Garth road, March.

Closterium fulvum sp. nov. Plate 16. Figs. 4, 5, 6.

Cells long, 12–26 times diameter, outer margin 20–25° of arc, inner margin straight or more often concave, not tumid; gradually attenuated toward the slightly recurved truncate invaginate apices; cell wall finely striated, 48–64 striae visible across the cell, striae composed of fine puncta, yellow to reddish-brown; chloroplast usually obscurely ridged, pyrenoids numerous; terminal vacuoles with several to many granules. Length 864–1200 μ, breadth 44–86 μ, breadth of apices 16–19 μ. Zygospore unknown.

Found in tadpoles from the old reservoir, September–December 1930, collected free-floating 1931. Probably at all seasons.

In many respects this species resembles *C. pritchardianum*, but is much longer and narrower. The punctate striae always continue to the apex where they converge. The puncta are more distinct in the apex, which is usually darker, resembling in this respect *C. didymotocum*. An invagination or indentation of the apex is always present.

Closterium ranunculi sp. nov. Plate 16. Figs. 1, 2, 3.

Cells long, 25–40 times diameter, moderately curved; median portion fairly straight and cylindrical, attenuated toward somewhat incurved apices, which are obliquely truncate and invaginate; cell wall striate, 6–18 striae visible across the cell, numerous puncta between the striae, striae unbroken lines except near apex, where they are resolved into puncta, yellowish to reddish brown; about 30 pyrenoids in each semicell; terminal vacuole with several granules. Length 885–1200 μ; breadth 22–36 μ. Zygospore unknown.

Found in tadpoles and free floating in old reservoir, September–May.

This species is longer and narrower than *C. fulvum*, straighter and incurved at the apices. The unbroken striae are much coarser and fewer in number, and between them lie numerous puncta irregularly arranged. The ends of *C. ranunculi* are not darkened.

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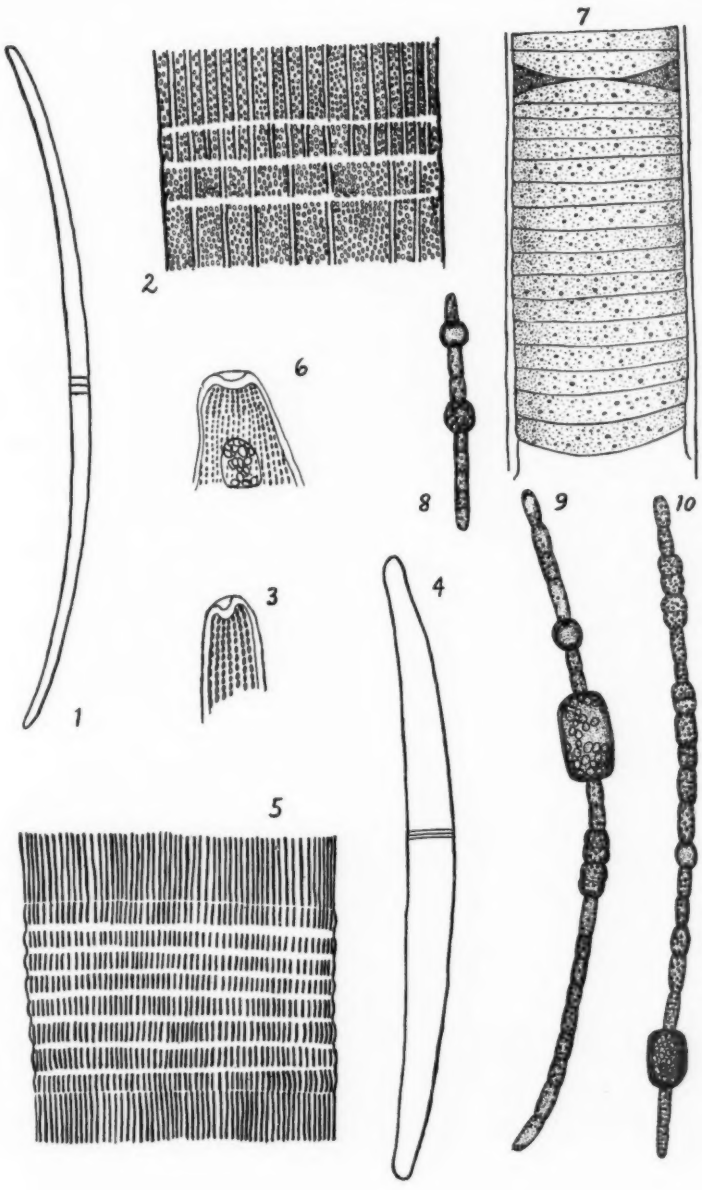
EXPLANATION OF PLATE 16

Fig. 1. General outline of *Closterium ranunculi*. ×142.
Fig. 2. Girdle view of *C. ranunculi*. ×1867.
Fig. 3. Apex of *C. ranunculi*. ×934.
Fig. 4. General outline of *C. fulvum*. ×150.
Fig. 5. Girdle view of *C. fulvum*. ×934.
Fig. 6. Apex of *C. fulvum*. ×142.
Fig. 7. *Lyngbya gigantea*. ×660.
Fig. 8, 9, 10. *Anabaena irregularis*. ×934.

PLATE 16



THE INGESTION OF LARGE AMEBAE BY THE CILIATE FRONTONIA LEUCAS

By C. Dale Beers

Plate 17

As is well known, the holotrichous ciliate *Frontonia leucas* feeds primarily on algae. Desmids, diatoms, and filamentous blue-green forms are its principal articles of food, though the ingestion of bacterial zoogloea, débris, euglenas, and other small, slowly moving protozoa is not uncommon. Astonishing distortions of the cell-body may result from the ingestion of large desmids (e.g., *Closterium*) and relatively long algal filaments.

The process by which desmids, filamentous algae, and the like are ingested has been studied in considerable detail by Goldsmith (1922), who cites five factors as being involved in the mechanics of ingestion. Three of these concern ciliary action: (1) A pull exerted on the incoming food by the circumoral cilia, (2) movement of the ciliate in the direction of the food through the action of its own body cilia, and (3) a series of orderly changes in the position of the *Frontonia* with reference to the food which permit the food to pass posteriorly with greater facility along the aboral (dorsal) wall of the ciliate. The two remaining factors involve physical changes in the cytoplasm: (4) Superficial contractions of the aboral surface of the ciliate which relieve undue local pressure of the food against the pellicle, and (5) cyclosis, which aids in moving the ingested end of the desmid or filament posteriorly.

The present paper adds another form, *Amoeba proteus*, to the list of food organisms given by Goldsmith and presents an account of the conditions necessary for the successful ingestion of food of this type.

A specimen of *Frontonia* which contained a remarkably large, hyaline vacuole was noted in a laboratory culture. In an attempt to ascertain the character of the vacuolar contents, the ciliate was transferred to a slide and gently crushed by the surface film. The ensuing disintegration of the cell disclosed an ingested ameba, which, upon being thus freed, moved away normally. Obviously digestion had not proceeded far. Further examination of the culture revealed other specimens of

Frontonia which contained similar large, clear food vacuoles. In order to observe the process of ingestion, a number of frontoniae were removed to spring water and deprived of food for a day. They were then transferred to culture slides, the depressions of which contained numbers of large specimens of *Amoeba proteus*. Under these conditions all stages in the process of ingestion were observed with but little difficulty, for the frontoniae attacked the amebae without delay.

Most of the attempts at ingestion resulted in failure. The outcome depended both on the size and on the configuration of the amebae. The ingestion of amebae which were creeping close to the substratum and which had a palmate form was never observed. Frontoniae approached such amebae and moved about over them characteristically, as though endeavoring to ascertain their nature, but no observable attempts at ingestion were made. The failure to engulf such amebae was evidently due to the inability of the ciliates to seize a projecting pseudopod.

Furthermore, the ingestion of amebae which were closely adherent to the substratum and moving in a monopodal condition or with only a few free pseudopods was never observed. The ends of the free pseudopods of such amebae were frequently engulfed momentarily, but when the process of ingestion had proceeded as far as the stage indicated in figure 1, the *Frontonia* withdrew, its attempts frustrated by the shape of the ameba. Similarly, attempts to ingest unattached amebae of the shape indicated in figure 1 or of a stellate shape were unsuccessful without exception.

The ingestion of large amebae was therefore confined primarily to monopodal individuals which were unattached, or to unattached individuals which departed from the monopodal condition in having only a few short lateral pseudopods. In rare instances attached amebae which were essentially monopodal and which were executing "walking movements" on the ends of their pseudopods in the manner described by Dellinger (1906) were ingested, but the shape of these usually offered difficulty, even though a *Frontonia* succeeded in detaching them.

Successive stages in the ingestion of a monopodal ameba are shown in figures 2–6. In the process of ingestion the *Frontonia*, after what appears to be a preliminary examination of the entire surface of the ameba, pushes its mouth over one end of the prey (fig. 2). This stage appears to be arrived at, as Goldsmith has pointed out, through the action of the body cilia which tend to push the *Frontonia* toward the ameba, and through the action of the oral cilia which tend to pull the

ameba inward. The mouth of the ciliate then moves along the ameba, until the ingested end of the latter protrudes the aboral wall of the *Frontonia* (fig. 3). Such an area of contact on the aboral surface is designated by Goldsmith as a "tension point." Thus far two of the ciliary factors (action of body cilia and circumoral cilia) have been active. At this stage the three remaining factors become operative. Certain characteristic contractions of the cytoplasm of the aboral region of the ciliate, together with the process of cyclosis, now move the ingested end of the ameba posteriorly (fig. 4), thus relieving the tension point (T) indicated in figure 3. By this means the longitudinal axis of the ciliate comes to lie more nearly parallel to the corresponding axis of the ameba. No doubt the body cilia aid in effecting this change of position. The mouth of the *Frontonia* now moves slowly in the direction of the free end of the ameba (fig. 4), and at length the ameba is completely ingested (fig. 5). Within half an hour the immense food vacuole thus formed has assumed a spherical shape (fig. 6), and the process of digestion is well under way.

The process just described was observed in numbers of instances, though by no means all attempts to ingest unattached, monopodal amebae were successful. In many cases the amebae were much too long to be ingested. In such cases the ingested end was ejected, either gradually or suddenly, when a stage similar to that of figure 3 was attained. Again, short lateral pseudopods offered difficulty, though in some cases the *Frontonia* succeeded in stretching its mouth over these. The ingestion of amebae which were fully one and a half times as long as the frontoniae was observed on several occasions.

The factors cited by Goldsmith appear to be entirely adequate to explain the mechanics of the ingestion process in *Frontonia*, and it can not be denied that these factors are constantly operative and that they are of great importance. Nevertheless, this does not imply that they are the only factors which are involved. Whether solation and gelation phenomena, such as accompany locomotion, movement, and ingestion in *Amoeba* (Mast, 1926), play a part in the ingestion process in *Frontonia* remains to be ascertained. It is entirely possible that such phenomena play a greater rôle than has been suspected, particularly when certain of the more remarkable feeding activities of *Amoeba* are considered. For example, *Amoeba* by means of the pressure of two apposed pseudopodal tips can cleave a *Paramecium* in half (Mast and Root, 1916), or by pseudopodal action it can stretch a *Paramecium* to nearly twice its normal length (Kepner and Whitlock, 1921) or actually stretch a

Frontonia in two (Beers, 1924). These are activities in which cilia play no part; they are the result of gelation, solation, contraction, and streaming of the cytoplasm. Further study may show these factors to be of great importance in the ingestion process in *Frontonia*. To illustrate, may not the mouth of the *Frontonia* at the stage indicated in figure 3 move toward the free end of the ameba as a result of solation and streaming at "A," accompanied by gelation and contraction in the region "B" around the engulfed half, the latter processes serving to hold in place the engulfed half? Such observations as I have had opportunity to make have been inconclusive, and the matter is mentioned merely as one worthy of further investigation.

SUMMARY

The ciliate *Frontonia leucas*, in addition to feeding on unicellular and filamentous algae, euglenas, and various kinds of débris, also feeds on large amebae.

Attached amebae and stellate or irregularly shaped unattached amebae are not as a rule ingested. Ingestion is therefore confined largely to unattached amebae which are essentially monopodal.

The factors involved in the ingestion of large amebae are not unlike those cited by Goldsmith (1922) as operative in the ingestion of desmids and algal filaments. They include the action of the body cilia and circumoral cilia, cyclosis, and characteristic contractions of the cell-body of the *Frontonia*.

The suggestion is made that phenomena of solation, gelation, and cytoplasmic contraction may be of greater importance in the mechanics of the ingestion process than has been formerly believed.

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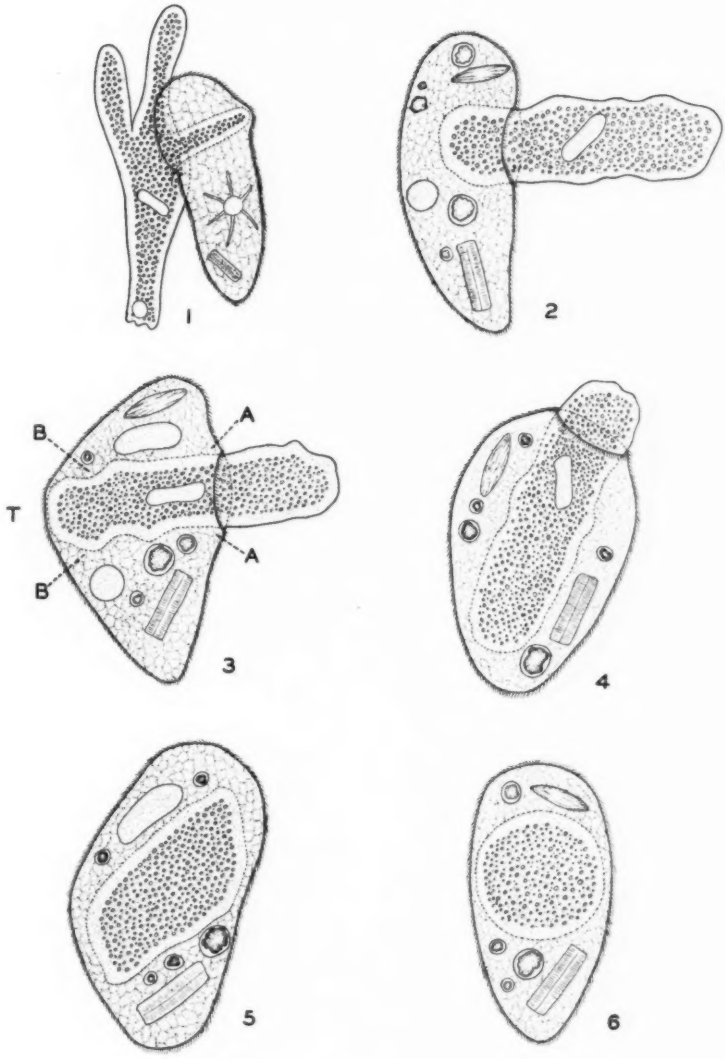
PLATE 17



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EXPLANATION OF PLATE 17

Fig. 1. *Frontonia leucas* attempting to ingest a large, attached specimen of *Amoeba proteus*. The shape of the ameba and its adherence to the substratum make ingestion impossible.

Fig. 2. Early stage in the ingestion of an unattached, monopodal ameba by a specimen of *Frontonia leucas*. The body cilia of the *Frontonia* tend to push the mouth over the ameba; the circumoral cilia aid in pulling the ameba inward.

Fig. 3. Continued ingestion of the ameba, resulting in the production of an area of tension (T) on the dorsal surface of the ciliate.

Fig. 4. Further stage in the process of ingestion. Two factors, cyclosis and certain characteristic contractions of the cytoplasm of the aboral region, move the ingested end of the ameba posteriorly, thus relieving the area of tension; the body cilia aid in bringing the longitudinal axis of the *Frontonia* parallel to the corresponding axis of the ameba, thus permitting the ingested end to pass posteriorly with less difficulty.

Fig. 5. Completion of the ingestion process, with marked distortion of the ciliate.

Fig. 6. Characteristic, hyaline food vacuole resulting from the ingestion of a large ameba.

A TREE-FROG NEW TO THE ATLANTIC COASTAL PLAIN

By Francis Harper

Plate 18

About 8.30 p.m. on April 25, 1932, while crossing the Ogeechee River swamp along U. S. Route 1, a couple of miles south of Louisville, Jefferson County, Georgia, I began to hear a larger chorus of amphibians than had come to my attention during several preceding weeks in the drought-stricken Okefinokee Swamp region. Rain was probably impending here, for it fell before daybreak in Columbia County, a little farther north. The chorus included the Southern Toad (*Bufo terrestris*), the Cricket Frog (*Acris gryllus*), the Green Tree-frog (*Hyla cinerea*), the Common Tree-toad (*Hyla versicolor*), the Common Bullfrog (*Rana catesbeiana*), and—most noticeable of all—some species whose birdlike voice I was at a loss to identify.

From the margin of the flooded river swamp, at the foot of the steep road embankment, I was able to hear perhaps a dozen of the unfamiliar vocalists within a short distance. Most of them seemed to be located a rod or two out from the shore, on trees, logs, or brush. After considerable search I found a couple of fallen trees projecting above the water, and on these I made my way out toward one of the voices. Presently I located with my flashlight a grayish little tree-frog clinging upright to the trunk of a small tree at a height of about a yard above the water. I waited long enough to see it call, in order to verify the authorship of the strange notes, and then captured it.

The call, as heard from this individual and its unseen fellows, consisted of a moderately rapid series of about 20 high-pitched, birdlike notes: *wit, wit, wit,* etc. The notes were delivered just a bit too slowly, however, to constitute an actual trill, such as was being uttered by near-by individuals of *Hyla versicolor.* They were also given at a much slower rate than the rolling notes of the Red-bellied Woodpecker, to which Viosca (1923, 1928) likens the voice of *Hyla avivoca.* The call lasted for a period of several seconds—much longer than that of *Hyla versicolor*—and the rate and pitch seemed to be practically uniform throughout. The alternate inflation and deflation of the vocal sac

during the call was fairly pronounced; yet the intervals between notes were so extremely brief that the degree of deflation probably did not amount to as much as 50 per cent. My observation of the single individual was too hasty to admit of a more precise statement.

A few minutes previously I had passed by a mated pair of tree-frogs, perched on a tree trunk at about the same height as the calling male. I had taken them to be merely *Hyla versicolor*, but now gathered them in on the way back to the road and presently had all three frogs stowed in a vasculum for safe keeping overnight. I anticipated no difficulty the following morning in distinguishing the single strange male from the pair of supposed *Hyla versicolor*. When examined by daylight, however, all three frogs were most obviously of the same species! Meanwhile some eggs had been deposited in the vasculum.

Examination of a series of *Hyla avivoca* in the U. S. National Museum a few days later, and a careful comparison of my Ogeechee River specimens with the original description and figures by Viosca (1928), left no doubt that these specimens represented *avivoca*, thus constituting the first record for the species in Georgia and on the Atlantic coastal plain.

The two males exhibit no noteworthy differences from Viosca's description. The measurements (in millimeters) of the two males and the female are, respectively, as follows: total length (snout to vent), 36, 35.5, 49; length of head (including tympanum), 11.5, 11, 15; width of head at posterior border of tympana, 12.5, 12.5, 18; length of arm from axilla, 22.5, 23, 33; length of leg from groin, 52.5, 52.5, 73; tibia, 17, 17, 23.5; heel to tip of fourth toe, 24, 24, 33. In coloration the female closely resembles the males, but its throat, instead of being 'peppered with dark,' is only lightly spotted. The sexual difference in size (assuming that the single female is of average proportions) is far greater than that recorded for *Hyla versicolor* (cf. Dickerson, 1906, p. 119, and Wright, 1931, p. 329). In fact, no equal discrepancy in the size of the sexes seems to be recorded for any of the other Hylidae of eastern North America. Viosca remarks (1928, p. 89) that the females of *Hyla avivoca* are larger than the males, but gives no measurements of the former. This species bears such a remarkable resemblance to *Hyla versicolor*, both in general appearance and in the details of its color pattern, that scarcely any one would detect the difference except by critical examination, or by hearing the voice.

An interesting reptilian associate of this tree-frog in the Ogeechee River swamp is the Copperbelly (*Natrix sipedon erythrogaster*), of which there do not appear to be many Georgia records. I found a

large dead specimen on the roadway at this point, and I also saw a large live individual, probably of the same species, in the edge of the swamp. The latter was uniformly colored above, but I did not ascertain its ventral coloration.

On the afternoon of the same day (April 25) I had stopped at the Ohoopee River swamp about 4 miles north of Oak Park, in Emanuel County, Georgia. Here I had heard some unfamiliar birdlike notes (which I suspected to belong to an amphibian), and in endeavoring to trace them to their source, I detected a *Hyla* about 8 feet up in a young cypress. I made a couple of attempts to grasp it, but the creature escaped, first by leaping to another limb, and then apparently to the ground. Its appearance corresponded very closely to that of the Ogeechee River individuals seen a few hours later, and I believe that it, too, was a *Hyla avivoca*. Another amphibian found in the Ohoopee River swamp was an Alligator Frog (*Rana heckscheri*), which I observed at close range in a pool and identified very satisfactorily, though I failed to capture it. This evidently constitutes the northernmost record for the Alligator Frog to date.

In his original description Viosca (1928) recorded *Hyla avivoca* only from Louisiana and Illinois. It is probably this same species, however, that was recorded a short time previously (under the name of *Hyla phaeocrypta* Cope) from Tennessee by Dunn (1927) and from Kansas by Burt (1928)—in each case on the basis of a single specimen. The foregoing scattered records suggest that the 'Bird-voiced Tree-frog' has a rather wide distribution in river and creek swamps of the central and lower Mississippi Valley as well as in certain parts of the coastal plain of Georgia (and probably Alabama).

Apparently the only information hitherto available concerning the habits of this species is contained in the two papers by Viosca cited above, and perhaps in one by Ridgway (1924). The latter's notes, however, deal with an unseen and undetermined species, and would seem quite applicable to *Hyla crucifer*.

SWARTHMORE, PA.

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PLATE 18

HYLA AVIVOCA, MALE

From Ogeechee River swamp near Louisville, Ga., April 26, 1932. Photographs taken the day after capture. The upper figure shows the frog on a mirror.

DUNN, E. R.
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PHTHIRACARID MITES OF FLORIDA

By Arthur Paul Jacot

Plates 19–22 and 2 Text Figures

INTRODUCTION

Between January 5th and the first of August, 1928, Mr. E. F. Grossman, with the coöperation of other workers of the Agricultural Experiment Station of the state of Florida, secured 126 lots of Acarina. Of at least seventy-five of the lots containing Oribatoids, Phthiracarids occurred in forty-three. The present paper is a report on these Phthiracaridae, kindly sent me for study by Dr. John W. Wilson, who is now in possession of the collection.

Rather than to repeat under each species the data related to each lot, this datum, published in the following paragraph, can be referred to by means of the lot numbers cited under each species. Lots not bearing a collector's name were secured by Mr. Grossman.

6. Leaves from ground about Azalea bushes, shady place, apiary grounds, Gainesville; Jan. 26 (?).

10. Leaves from ground, sunny, rather dry, live oak and pine, very little grass, Perry; Feb. 2.

11. Leaves from ground, sunny road-side, live oak and pine, very little grass, Mayo; Feb. 8.

13. Wet leaves from moist ground, rainy and cloudy all day, horticulture grounds (third row from Japanese plum, 28th and 29th tree from woods), Gainesville; Feb. 13.

21. Palmetto scrubs and scrub oak, North Beach, St. Augustine; Feb. 19.

23. Pine needle litter of 12–16 inch pine trees, not burned off for several years, soil moist, very few scrub oak present, high land two miles west of Madison; Feb. 23.

28. Leaves from base of trees in an abandoned orange grove, five miles beyond Micanopy; Feb. 26.

29. Leaves from under small elders from which 26 collections were made from half to three-quarter inch leaf mulch, rather damp, magnolia, elder, prickly oak and live oak leaves mixed in, horticulture grounds, Gainesville; Feb. 29.

30. One inch leaf mulch, shady spot, quite damp, no elders, horticulture grounds, Gainesville; Feb. 29.

33. Leaves from half inch undisturbed mulch, soil slightly moist, high, dry land under hickory tree, Pinkoson Springs, Gainesville; March 4.

34. Leaves from shore bay under *Tamola littoralis* Small, tree on inner edge of twenty foot sand dune on ocean edge, seven miles from south point on North Beach, St. Augustine; March 7.

35. Sod and litter of colony of sea oats (*Uniola paniculata* L.), south point (ten feet elevation), North Beach, St. Augustine; March 7.

44. Leaves and grass from ground, old Bradenton Laboratory, Bradenton; March 14; coll. by George F. Weber.

45. Cortez; March 15; Weber.

TEXT-FIGURE 1. OUTLINE MAP OF FLORIDA INCLUDING LOCALITIES FOR THE FORTY-THREE LOTS AND THE JANUARY ISOTHERMS

48. Spruce and pine needles and small limbs from ground, burned land, Orange Heights; March 18.

54. Needles from long leaf pine, east shore of Newmans Lake, Gainesville; March 25.

55. Same, from south shore.

61. Litter from second growth pine, east of Oscuala Country Club, five miles west of Pensacola; March 29; coll. by G. H. Blackmon.

62. Pine needles and live oak leaves from level but low land, three miles northwest of Milton; March 29; Blackmon.

63. Litter (?), twelve miles from south point on shore of North Beach, St. Augustine; April 1.

67. Shore bay débris, Vero Beach; April 6; coll. by Erdman West.
69. Live oak leaves, east side of St. John's River, East Palatka; April 15.
74. Leaves from sweet-gum, three miles southwest of Micanopy; April 17.
75. Leaves from ground, horticulture grounds, Gainesville; April 21.
76. Oak leaves, upper edge of Devil's Mill Hopper, Gainesville; April 24.
77. Green moss and damp grass, lower part of Devil's Mill Hopper, Gainesville; April 24.
80. Leaves from oak woods, on state road one mile west of Green Cove Springs; April 29.
81. Damp leaves from edge of water in Devil's Hole, two miles north of Edgar on Hawthorne-Palatka road, about eight miles from Hawthorne; May 1.
82. Leaf litter of live oak, one mile north of Crescent City; May 1.
84. Dry oak leaves, horticulture grounds, Gainesville; April 27; coll. by Homer F. Bratley.
87. Leaf litter, locality of lot 44; May 2; Weber.
90. Dry leaves, near insectary, horticulture grounds, Gainesville; Bratley.
92. Dry leaves, Key Largo; May 10; Weber.
95. Dry leaves, Bonita Springs; May 4; coll. by James R. Watson.
101. Leaves from beneath oak, magnolia and hickory trees, no pine, National Forest, one mile east of Villa Tasso on Choctawhatchee Bay; May 18; coll. by R. W. Blacklock.
103. Leaves beneath water oak tree, one mile east of Mulberry; May 17; coll. by West.
105. Leaves from ground, Eustis; June 20.
108. Elder leaves, White City; May 28; coll. by Watson.
109. True moss, Sugarfoot Hammock, Gainesville; June 10; Watson.
111. Large leaves from wood fern common in Florida, Gainesville; May 28; Bratley.
113. Débris from hammock land; Fort Lauderdale; March 25; coll. by D. M. Bates.
115. Live oak and pine leaves from ground, Wellborn; May 30.
116. Live oak leaves; Gainesville; May 30.

SYSTEMATIC ACCOUNT

In 1923 (14) I recognized three families of Ptyctyma. At the present time I do not regard these groups as sufficiently differentiated to consider them of higher rank than subfamilies. The recent outstanding contribution of Grandjean (9) necessitates changes in the key then published, as follows:

Abdomen covered by telescoping plates, and therefore capable of considerable contraction and expansion.....Protoplophorinae
Abdomen covered by a single plate
Genital and anal openings united.....Phthiracarinae
Genital and anal openings distinct, separate.....Mesoplophorinae

Subfamily **Protoplophorinae** (17, p. 210)

Characters: Dorsal area of abdomen covered by at least two notogastral plates, the posterior one (pygidium) capable of telescoping under the anterior one (pronotaspis) and usually found in this position in preserved material; sides covered by freely movable, lateral plates (pleuraspides), as far as now known, one on each side.

Type: Protoplophora (3, p. 217).

Genus **Aedoplophora** (9, pp. 12 and 29)

Characters: Sides of aspis pushed out to form an angular rim which converges rapidly on apical third to form a terminal prow; palps five segmented; the two transverse ridges of pygidium fairly close together; anterior edge of pleuraspides barely or not lobed; anal covers each formed of two fused plates and thus bearing two rows of bristles.

Type: *Aedoplophora glomerata* (9, p. 12, monotypical).

1. **Aedoplophora major** *sp. nov.*

Figures 1–9

Diagnostic characters: Pseudostigmatic organs with a flattened head bearing rows of not particularly short bristles (figures 1, 2, 5); vertical bristles as long as rostral; four median bristles of pronotaspis as long as vertical; each anal cover with three major bristles.

Dimensions (of a medium sized individual):

Length of pronotaspis, 265; of aspis, 210
Breadth of same, 225; of aspis, 200

Description: Aspis sanded, except lateral portion; with distinct carina running from tip of rostrum nearly to pseudostigmata. In the one lateral aspect (figure 2) the carina did not show up distinctly but in the two dissections it is very strongly marked. That it is a sharp, distinct angle is evident from figure 4. There also appears to be a slight subsidiary ridge just mediad of the carina (figure 5). Proximal edge of aspis strengthened by a raised, chitinous band. It was impossible to locate definitely one of the pairs of bristles. The rostral bristles were clearly visible. In figure 2 one is shown projecting beyond the carinal bulge because of the angle at which it is seen. The bristles of the other pair are inserted close to the pseudostigmata. The bristle of figure 2

is evidently the same for the further side. There seems to be an insertion distad of the pseudostigmata but I have not been able to discern a bristle. The two exopseudostigmatal bristles are shown in figure 5.

Pronotaspis (figure 2) sanded; with a distinct collar of some breadth (figure 3), terminating in a thickened ridge. The four median bristles (a:1 and a:2) inserted near it. Bristles a:1 as approximate as a:1 is distant from a:2. Bristles a:3 were not discernible but what appears to be an insertion was observed as in figures 2 and 3. Bristles a:4 far posteriad (figures 2 and 4). Pygidium (broken line in figure 2) at least partly sanded; very similar to that of *Aedoplophora glomerata* but peripheral bristles in a straighter row. I designate bristles of first transverse ridge as b, those of second ridge as c, and the peripheral as d. Bristles b:1 slightly more approximate than are a:1; b:1 to b:2 equals b:1 to b:1; c:1 still more approximate; c:1 to c:2 equals b:1 to b:1; d:1 slightly more approximate than c:1. In figure 4, I have shown only bristles d:1 of the peripheral row.

Pleuraspides (figure 6, where it is in the same position as in figure 2) sanded, except outer edge which is very thin; with a distinct ridge or apodeme running from end to end. This seems to be the skin fold of Grandjean or at least the point of attachment of the ventral membrane. The central portion of the apodeme is really double and the angle is produced as a keel or lapet (figure 7, stippled area) under which the anal cover is housed or held in place. In figure 2, I distinctly saw a bristle on the anteroventral edge, i.e. opposite the genital aperture (which, in this figure, is indicated by broken lines). This is also shown in figure 4. In figure 6 the two distinct bristle insertions are shown as heavy circles, the lighter ones being uncertain. I have been unable to locate the anterior bristle in the pleuraspides dissected out.

Anal covers together shaped like half a lemon peel, if the lemon is cut from end to end. The terminal nubbins articulate with the posterior corner of the pleuraspides; edges of the covers are somewhat undulate at their posterior end; center of each cover bears a longitudinal ridge on which are inserted three, long, curved bristles (figures 6 and 7). Each cover is produced laterad in the form of an *articular arm*. This arm is at a lower level than the face of the cover (figure 8). The arm is composed of two ribs, one running out from the proximal part of the cover and a longer one running out from the distal corner (figure 7). They meet to form a triangular knob (figure 7) which articulates beneath the flange of the pleuraspal apodeme (figure 7, where the flange is stippled). In figure 6 this arm appears dorsad of the cover, running obliquely to-

ward the apodeme flange. In figure 4 the arms appear as lateral angles to the proximolateral corners of the covers; this is due to their great foreshortening in this aspect. A row of seven to eight, fine bristles are inserted at juncture of anal cover and its arm (figure 7). The skin fold described and figured in that species, very much resembles the outline of the articular arm.

Tarsi I have ciliate, ventral face bristles. The palps (figure 9) bear fairly long, evenly curved, fine bristles.

Type locality: Key Largo; from dry leaves, taken May 10th by G. F. Weber; four specimens; slides G92P1 and P3 to P5.

Subfamily **Phthiracarinae** (17)

I find no *special* reason for studying the mouthparts and the legs of the Phthiracarinae at the *present* time. Trägårdh has figured *mandibles* about twenty-nine times while I have figured them eight times (besides observing them many more times). I do not consider that the *specific* differences in the *mandibles* are of such systematic value as to warrant spending the necessary time to figure or note them. That their study has "philosophic" value, I do not doubt. That is for another generation to determine.

For dimensions the greatest (diagonal) length of notogaster and the greatest height of notogaster (not including nubbins) is used because the total height of the animal varies with degree of retraction of genital and anal covers. For instance when these animals are expanded (extended) the genital and especially the anal covers are drawn well into the body, when the animal is closed up these covers are pushed out to their maximum extent. This is not so true of Steganacarus. Total length of aspis is from proximal end of same as seen through the wall of the notogaster. Unless otherwise specified, dimensions are in microns.

Paragraphs which seem to be copied out of my earlier paper (17) bear corrections or modifications. Grandjean's (9) important contribution on the Protoplophorinae requires reconsideration of certain structures in the Phthiracarinae. According to his studies, the notogaster is made up of four plates which he designates: pronotaspis, pygidium and pleuraspis (a pair). The ventral plate he regards as the ventral portion of the pleuraspides. The dorsal edge of the ventral plate he considers the "dorsoventral line of attachment" of the "ventral membrane." After careful reëxamination of material on hand, I am convinced that this "line," in the Phthiracarinae, is a ridge or apodeme. This apodeme runs along the longitudinal center of the pleuraspides.

Thus the ventral plate would actually extend dorsad of this apodeme. I am, for simplicity, retaining the term ventral plate in this report with the understanding that its dorsal edge is dorsad of the *ventral membrane apodeme*. *Hypochthonius rufulus* clearly shows the pleuraspides.

Another observation is that my VP:1 and VP:2 are the two bristles of the pleuraspides. (I also suspect that the postanal bristles of the Galumnidae are homologous.) A study of the figures of *Ph. setosum*, *Steganacarus diaphanum*, *Steg. thoreaui* (17) will show that VP:3 is above the phragma while VP:1 and 2 are below it. In the Protoplophorinae, I find nothing to correspond with VP:3, unless it be the bristle of figure 2.

Finally the bristles I:1, II:1, III:1 and III:2 are homologous with bristles of the pronotaspis; bristles I:2 and II:2 with those of the first transverse ridge of the pygidium; bristles I:3 and II:3 with those of the second ridge; while I:4, I:5, II:4 and III:3 are homologous with the peripheral bristles. This gives a total of twenty-four notogastral which, with the four VP:1 and VP:2, totals twenty-eight. This leaves VP:3 unaccounted for!

In view of this transverse segmentation and the consequent primitive arrangement of the bristles in transverse rows, the system of enumeration of the bristles which I have been using should be modified to accord with this homology. In the present report I follow the former system, but in a forthcoming paper I will use letters to denote the transverse rows, and numerals to denote sequence from median plane, I:1 becoming a:1, II:1 becoming a:2, I:2 becoming b:1, and so on.

I am of the opinion that further research will show the pygidium of the Protoplophorinae to be made up of more than one segment.

Key to Tribes

Anogenital area about as broad (or broader) than length of any one of the four rectangular plates, and never as long as ventral face of abdomen
Phthiracarini (figures 10–24)

Anogenital area much narrower than length of any one of the two or four strap-like plates; and extending along entire length of abdomen
Euphthiracarini (figures 26–32).

Tribe PHTHIRACARINI (17, p. 214)

Form usually globular, oval or depressed, rarely compressed; chitin usually thin, dark, tending to olivaceous greenish and dark brown as seen in balsam mounts by indirect illumination; sides of aspis occasionally slightly angled, forming the *carina* which limits the lapet when

animal is closed; rib short, not conspicuous; pseudostigmatic organs usually simple, below them and below aspis rim is usually inserted a fine bristle, the *nuchal bristle*; collar rather thin, and not prominent; lapet well developed and prominent; ventral plate complete around the posterior end of the anal covers, not bent inward; anal and genital covers large, more or less quadrangular and contiguous, with central corners usually modified in the form of *nubbins* to interlock, adjacent edges also warped and curved so as to complement, and evidently opening and closing together; an *accessory plate* within anterior edge of genital covers, which normally lies against inturned rim of genital covers but is often retracted so as to be some distance dorsad or drawn into abdominal cavity so as to be invisible from outside. Its distal end is usually visible projecting ventrad of lapet (figure 23). Each side of aspis usually with a recess (appearing as a clear area or spot at anteroventral aspect of aspis, and referred to as *accessory plate notch*) into which the lateral end of this plate fits when aspis is closed (see figure 14). Genital covers each with three series of bristles: an *anterior*, within the anterior rim, usually consisting of three, directed forward and registering approach of aspis, a *marginal*, usually comprising two bristles situated within anterior half of inner margin and directed toward each other and registering closure of covers, and an *outer*, usually of four bristles, situated a short distance from inner edge and registering contact of covers with outside objects; ungues armed with a single, fairly large, often toothed hook.

Key to Genera

1. Anal covers quite flattened, often completely retracted into body cavity, their median edge bearing but two well spaced bristles (figures 10, 12, 14, 16) 2
1. Anal covers strongly convex, thus prominently protruding beyond ventral plate, and bearing at least three closely spaced bristles along median edge (figures 18 and 23) 3
2. Vertical bristles prominent and erect ..... New genus (see below)
2. Vertical bristles invisible or lying close to surface of aspis ..... *Phthiracarus*
3. Anal covers with three closely and subequally spaced bristles along median edge ..... *Hoplophorella*
3. Anal covers with four closely and subequally spaced bristles along median edge ..... *Steganacarus*

Genus **Hoplophthiracarus** *gen. nov.*

Characters: Phthiracarini similar to species of the genus Phthiracarus but differing in that the vertical bristles are erect and therefore con-

spicuous. Areolation or sculpturing of the surface is also developed in some species. These species I consider more primitive than those of the genus Phthiracarus because the vertical bristles of other Oribatoidea and Acarina are erect, as well as the notogastral bristles. Thus the procumbent bristles of the Phthiracarini are a specialization.

Type: *Hoploderma histricinum* (2, p. 12).

2. **Hoplophthiracarus histricinum** (2, p. 12) comb. nov.

Figures 14, 15

Diagnostic characters: Body rather small (abdomen 0.4 mm. long); oval; greyish green to pale brown or even pale rustaceous brown; notogastral bristles stout, rather straight; aspis flattish with protruding rim; rostral bristles easily seen; pseudostigmatic organs long, slender, angularly curved, slightly thickened at apex; surface of notogaster and dorsal face of aspis with areoles of dots.

Dimensions (of nine measurable specimens):

Length of notogaster,	369(393)411;	of aspis, 205(209)217
Height of same,*	221(235)248;	of aspis, 86 (88) 90
Breadth of same,	246(280)300;	of aspis, 139(155)164

Thus this species is distinctly depressed, so that mounted specimens showing side view are rare (unless broken open). In studying the next species, three much larger specimens were found.

Description: Aspis seen from side (figure 14) flattish, with prominent angle between dorsal and anterior face, roughened by areoles which are visible chiefly on dorsal face, anterior face also flattish; no ridge; a faint carina; accessory plate notch large, similar to that of preceding species; rim distinct, well formed, protruding conspicuously; rib short but stout; vertical bristles the longest of the body, slightly bent near middle; rostral bristles curved, inserted near anterodorsal angle of aspis, twice as approximate as vertical; lateral bristles very small (figure 15), distant from pseudostigmata; lid small, barely covering orifice; pseudostigmatic organs smooth at apex.

Notogaster seen from side (figure 14) with rather low posterior end, highest just anterior to middle, seen from above (figure 15) broadly rounded behind, quite flat in front; surface granular, granules usually aggregated into rough circles giving it a pockmarked appearance.

* Two measurements only.

These circles contain from five to seven such points. In some individuals with evenly granular surface, there is faint pocking on the interior surface of the chitin wall. These pocks when strongly developed are separated by interstices the diameter of which is at least half that of the pocks. This great variation in sculpturing led the Italian acarologist to use a varietal name. All intergrades occur. Collar narrow, undulate; notch very oblique; lapet rather long, strongly tapering; bristles stout, rather straight, sometimes slightly barbed at distal end; I:1–5, II:1–4, III:1–3; I:1 distant from collar, III:1 on longitudinal plane dorsad of pseudostigmata, and therefore higher up than III:2; a pseudofissura (?) anterior to II:3; I:2 much more remote than I:1, I:3 only slightly more approximate than I:2, thus median series are rather widely spaced.

Ventral plate sanded, most restricted at posterior end of genital covers; denticles well developed, slender (figure 15); bristles 1 and 2 inserted in crescentic notches, bristles 3 entirely above ventral plate; accessory plate with rather rounded end (figure 14). Genital covers quite rectangular, with low anterior rim, like the anal plate somewhat sanded-pebbled, sometimes with granular areoles in restricted areas; bristles evident (figure 14), spaced as in figure 15 though the members of a pair are not always opposite; median edge notched near posterior end; posteromedian corner somewhat drawn out. Anal covers with sides well rounded out (figure 15); internal crossbar slender but strongly bent; anteromedian corner strongly drawn out into a rather long nubbin; bristles of median row much shorter than those of lateral row, rather close together; lateral bristles unusually close to median plane, II:2 on transverse plane of I:1, II:3 at least as close to I:2 as I:2 is to I:1.

This species so closely resembles species of Steganacarus that I at first took it for one of them but the anal covers are entirely different. Its type locality is North America! This term may have been used by Berlese for species occurring both in Missouri and Florida. Its author, who described and reported eighty-two species and subspecies from North America, received material from three states: Florida (especially Lake City), Washington, D. C., and Columbia, Mo. The type locality of the subspecies is: "Florida." If the description is meager, the figure and the description of the pseudostigmatic organs leaves no doubt as to its identity. For instance the anal covers are distinctly *not* those of a Steganacarus. The long, nearly straight bristles are distinctive and give the specific name of "little hedgehog." The description states that there is no carina (which I call ridge), thus again it is not a Steganacarus.

The species description calls for "a coat which is lightly rough-punctulate." Then in parentheses, as though unimportant or indistinct, is added: "rounded, widely placed areoles, *between* which the coat is minutely punctulate." In the variety (*P. h. nitidior*) "the coat is not distinctly pock-marked, areoles punctate but nearly smooth, entirely densely punctate; outline of areoles nearly evanescent, difficult to distinguish." As stated above, this distinction is not constant and intergrades are as common as the extremes, though the form with punctate areoles is the most common. The size difference is significant especially when taken with the chestnut (not earthy) color.

Occurrence: Pensacola (one specimen: G61), Perry (one specimen: G10), Gainesville (one specimen: G77), Bradenton (nineteen specimens from two lots: G44, G87). Thus along the west coast but most abundant from leaves about the old Bradenton laboratory.

In the present material, I find a form closely resembling *P. histricinum* but larger and darker, a good brown, but, unlike *P. h. nitidior*, the specimens are coarsely areolated, the interstices forming a conspicuous network. If anything, the pale colored, smaller *P. histricinum*, at least some of the specimens, would be *P. h. nitidior*, i.e., somewhat shining. Thus this larger, rougher, brown form, secured only from the west end of the state, requires designation and may be known as:

3. **Hoplophthiracarus robustior** *sp. nov.*

Figures 16, 17

Diagnostic characters: Deep amber brown; strongly reticulate, elongate; aspis more vaulted, not flattened; rostrum produced well beyond the very slender rim; carina distinct; vertical bristles straight, distal half swollen, rough; pseudostigmatic organs shorter and stouter than in preceding species; bristles of anterior part of notogaster not tapering, all notogastral bristles rough along distal third, ribbed, i.e., square in cross-section, and almost straight except II:1 which is strongly bent posteriad and swollen along distal third.

Dimensions (of four measurable specimens):

Length of notogaster,	435(454)496;	of aspis, 225(241)263
Height of same,	262(290)332;	of aspis, 107(110)115
Breadth of same,	287(295)313;	of aspis, 143(162)168

Thus this species is about as broad as high.

Description: This species is so much like the preceding that a detailed description would be needless repetition. Notogastral bristles I:1 are three times as remote as rostral, I:5 very slightly more remote than I:1, ventral plate bristles 3 are twice as remote as notogastral I:1.

The anal and genital covers are scrolled, i.e., they have no definite pockmarking. The anal covers have the median edge raised as a slight rim or bead. This rim fits into the ventral plate denticle notch which is more of a groove than a notch but appears as a notch when viewed in ventral aspect which is obliquely to the face of that part of the plate. Figure 17 illustrates this groove, the denticles, and the areolations as they appear when viewed at right angles to the plate. Thus these denticles and notch are useful in insuring the proper set of the anal covers and preventing tortion by external agents. The denticles are longer than in *H. histricinum* and the notch shallower, thus making a striking contrast.

Occurrence: The thirteen specimens before me all came from one lot taken five miles west of Pensacola from second growth pine, March 29th (G61).

Intermediates: Three specimens of *H. histricinum* from Bradenton are 450 micra long and therefore as large as average *H. robustior.* In all other characters they are *H. histricinum.* Similarly, one of the specimens of *H. robustior* is only 350 micra long though typical in all other respects. If these two species should be found to have structural characters mixed, it would indicate that *H. robustior* is a subspecies or geographical race of *H. histricinum.*

4. **Hoplophthiracarus grossmani** *sp. nov.*

Figures 12, 13

Diagnostic characters: Body small, depressed, low anteriorly; greyish green; notogastral bristles bent anteriad; aspis with very slight median ridge; no distinct rim; rostral bristles fairly long, straight; pseudostigmatic organs long, stout, curved anteriad and dorsad, so that the pointed distal end reaches nearly opposite dorsal edge of aspis (figure 12).

Dimensions (of two specimens):

Length of notogaster,	304 and 382,	of aspis,	152 and 197
Height of same,	205 —,	of aspis,	61 —
Breadth of same,	— 250,	of aspis,	103 and 150

Description: Aspis (figure 12) not large, blunt, with a slight carina; in lateral profile, highest at insertion of vertical bristles, angled close to transverse plane of pseudostigmata; no thickened rim though edge of aspis flares outward; accessory plate notch small but high; a distinct angle between dorsal and anterior faces; rostral bristles inserted well proximad of this angle, straight, fairly long; lid small; what may be regarded as a slight carina descends from dorsal edge of pseudostigmata towards rib; vertical bristles longest of body, curved posteriad; pseudostigmatic organ is so long and cumbersome as to be broken off short in three out of four (see figure 13).

Notogaster seen from side (figure 12) ovate, largest at posterior third, anterior edge flattened, anterior aperture small, flattish behind; seen from above (figure 13) slightly ovate, broadly rounded behind; collar narrow, angularly curved; lapet prominent; notch deep; bristles well developed, curved anteriad, insertions simple; I:1–5, II:1–4, III:1–2 or 3; I:1 not on collar, I:1 as remote as I:2, I:3 slightly more approximate, I:4 and I:5 still more approximate, III:3 was not discernible in the two specimens at hand.

Ventral plate conspicuously produced mediad anterior to posterior edge of genital covers; denticles rather in the form of a median notch; bristles inserted on edge of plate (figure 13). Genital covers with low, blunt anterior rim; posteromedian corner produced as a tooth to fit into a corresponding notch in the anal covers; bristles not discernible, judging from the two specimens before me, arranged as in figure 13. Anal covers much longer than genital, considerably broader behind than in front (figure 13); bristles well developed, I:1 and I:2 unusually close together, II:2 inserted on transverse plane passing just anterior to I:2.

Closely related to *P. pavidus* of Europe but with a different pseudostigmatic organ. It resembles *H. illinoiensis* but has stouter pseudostigmatic organs, slender, curved notogastral bristles, and the chitin has a sanded surface.

Occurrence: Pinkoson Springs, Gainesville, taken March 4th from half inch of leaf mulch under hickory, high, dry but slightly moist on soil, one specimen: G33; Vero Beach, taken April 6th, from shore bay débris, one specimen: G67.

Genus **Phthiracarus** (21, p. 874)

Characters: Phthiracarini with chitin thin and relatively smooth, when seen under high magnification sanded (irregularly stippled) or

finely, irregularly vermiculate or scrolled; setae usually fine to lacking, those of aspis usually difficult to distinguish, never erect, the median pair low down on sides; aspis without distinct median ridge (carina); rim usually distinct and well formed; lid descending from above backward, free from aspis behind pseudostigmata; bristle insertions most often simple and direct; middle of sides of notogastral plate with an indefinite, darker spot resembling a bristle insertion; ventral plate broad behind anal covers; anal covers not conspicuously convex, the bristles disposed in two rows: a *median* (referred to by Roman numeral I) and a *lateral* (designated by II); the median series usually consisting of three well spaced bristles, the lateral series of two; anterior edge of covers on interior face with a well-developed, posteriorly curved crossbar which throws a dark, shadowy band across covers at this point; genital covers with posteriorly directed lobe which fits under anal covers and into hollow of the anal cover cross-band.

The term Hoploderma (20, p. 77) was instituted to supplant the preoccupied name Hoplophora (19, p. 116) and thus by international rules takes the same type: *H. laevigata* which is synonymous with the type of Phthiracarus (21, p. 874). German acarologists use the term for pitted or rough species with *H. laevigata* (meaning smooth) as type!

5. **Phthiracarus sphaerulum** (1, p. 16)

Diagnostic characters: Body extremely variable in size, abdomen 0.4–0.8 mm. long, nearly as high, compressed; seen from side, nearly circular, very high, vaulted, with anterior part usually descending steeply; aspis low, oblong, with blunt, full rostrum; rim distinct, well formed, protruding; carina distinct; pseudostigmatic organ short, lanceolate; abdominal bristles very fine, medium-short, often crinkled at base; ventral plate with distinct posterior rim; anal cover bristles I:2 and I:3 long, fairly close; II:1 usually visible anterior to I:2.

This species has already been described and figured in detail (17, p. 223, pl. 33, figs. 1–5).

Size difference: Of the dozen specimens available for study, two belonged to the large size group and were of average size for that group. The smallest specimen was slightly larger than the average size for the small size group. Although this is far too small a number on which to base any size comparison, it may be noted that these Florida specimens show no marked size difference with specimens from the northeastern states.

Distribution: Florida to Connecticut and New York. Epixylous.

The largest and commonest species of this tribe taken in Florida (though from only seven lots out of about seventy-five bearing Oribatoidea).

Florida localities: Wellborn (one specimen: G115), Gainesville (four specimens from three lots: G29, G30, G75), Pinkoson Springs (one specimen: G33), Micanopy (three specimens: G74), White City (one specimen: G108).

6. **Phthiracarus prior** *sp. nov.*

Figures 10, 11

Diagnostic characters: Size small, notogaster averaging 0.34 mm. in length; with very fine, rather short bristles; vertical bristles not discernible; aspal carina lacking; pseudostigmatic organs almost long, scimiter-like; ventral plate without denticles; genital and anal covers quite simple, anal bristles II:1 and II:2 not discernible (not developed).

Dimensions (of two of the four specimens):

Length of notogaster,	344;	of aspis, 217
Height of same,	242;	of aspis, 80
Breadth of same,	226;	of aspis, 127

Thus the notogaster is only slightly higher than broad.

Description: Aspis relatively large, high near distal end; lateral profile of dorsal face convex, with a slight depression at transverse plane of pseudostigmata, rostrum blunt so that the slender rim does not project beyond it; carina not visible; accessory plate notch low, elongate; rostral bristles very fine, inserted well up on rostrum, barely projecting, strongly decurved, fairly approximate (figure 11); other bristles seem to be lacking; angle distant from transverse plane of pseudostigmata; lid short, covering over half the pseudostigmata; pseudostigmatic organs rather long, blade-like, apex incurved (figure 11) and decurved (figure 10).

Notogaster seen from side, high for its length, well curved, barely descending at anterior end, leaving anterior end of abdomen with large aperture thus necessitating the large aspis, descending rapidly behind, thus highest at anterior end; seen from above: oval, broadly rounded behind, anterior edge flattened, slightly impressed above pseudostigmata; collar broad, but little curved; lapet poorly developed; notch shallow, angular; bristles extremely fine and difficult to discern, tapering to a very fine point, usually curved; I:1–5, II:1–4, III:1–3; I:1 just within edge of collar, more remote than I:2, II:1 not or doubtfully discerned; pseudoforamina as in figures 1 and 2.

Ventral plate broadly rounded behind; bristles inserted below edge of plate, rim distinct, no denticles. Genital covers slightly tapering, nearly as broad as long; nubbins poorly developed; bristles nearly as well developed as usual, erect, median series very close together. Anal covers broad, broadly rounded; only bristles I:1 and I:2 visible, rather closely spaced, correspondingly short and fine, I:3 not discerned. The broken line in figure 11 between the two parallel curved lines indicates edge of anal cover under ventral plate.

Closely related to *Ph. setosellum* (17, p. 231) but smaller and, as the name suggests, more primitive or undeveloped as to bristles, and condition of anal and genital covers, lapet, and aspal rim. Its more anteriorly open abdomen may also be a more primitive character.

Occurrence: Pinkoson Springs, Gainesville (three specimens: G33), East Palatka (one specimen: G69). All cotypes.

Phthiracarus curtulus (5, p. 259–260) is recorded from Florida though the type locality is Etruria, Italy. That Phthiracarus was to Berlese in 1923 as Phthiracarini is now understood, is evident from his synonymizing it to Hoplophora of Koch and placing in it *H. cucullatum*, *H. magna*, and *H. carinata* which he makes genotypes for sculptured species in this same paper, thus leaving the smooth species in Phthiracarus *sensu strictu*. The distinguishing characteristic of this species is the pseudostigmatic organs which are, "very short, clavate, barely conspicuous, with a roundly truncate apex." Such an organ I have not yet seen in this family.

Genus **Hoplophorella** (5, p. 260)

Characters: Phthiracarini similar to species of Steganacarus in that the chitin is usually areolated or otherwise sculptured, and the anal covers are strongly convex, thus prominently protruding beyond ventral plate and line of genital covers (as seen in side view) but differing in that the anal covers bear only three, subequally spaced bristles on median edge.

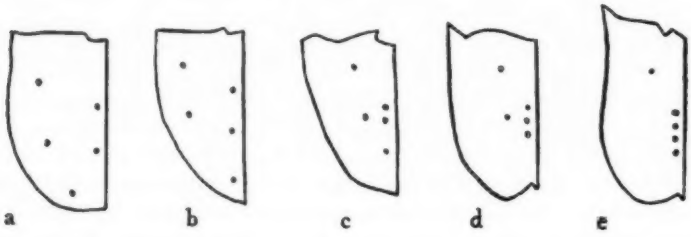
Type: *H. cucullatum* (8, p. 133, pl. 6, fig. 35).

The concentration of the bristles of the anal covers along the median edge as a definite trend among the Phthiracarini becomes evident when one reviews the condition in the various species. For instance, reference to the figures of the species of Phthiracarini of the northeastern states (17, pls. 33–36) shows the typical arrangement of these bristles to be: I:1 and I:2 close to median edge and not closely spaced, and II:3 not close to median edge (17, pl. 33, fig. 5). This is also the condition in the

more primitive genus Hoplophthiracarus. A more advanced stage is where I:1 and I:2 are closely spaced (17, pl. 34, fig. 10) or II:3 come close to the median edge of the covers (17, pl. 34, fig. 18, pl. 35, fig. 21, pl. 36, fig. 28). A still more advanced condition is where I:1 and I:2 are closely spaced and II:3 are on the median edge of the covers (17, pl. 36, fig. 32). This last species is still more advanced in that II:2 are close to the median pair.

In Hoplophorella I:1, I:2 and II:3 have come close together on the median edge and II:2 are usually close to this trio (17, pl. 37, fig. 43,—*Steganacarus thoreaui* thus becomes *Hoplophorella thoreaui* **comb. nov.**).

In Steganacarus II:2 come into line with the median trio forming a median quartette (17, pl. 37, fig. 37).



TEXT-FIGURE 2. ANAL COVER OF: *a*, HOPLOPHTHIRACARUS; *b* AND *c*, PHTHIRACARUS; *d*, HOPLOPHORELLA; *e*, STEGANACARUS

It is interesting to note that the majority of American species belong to the more primitive Hoplophorella while the majority, if not all, of the European species belong to the more specialized genus Steganacarus.

The genotypes of Steganacarus, Tropacarus, Atropacarus, and Trachyhoplophora all have the four bristles on the median edge.

In my earlier paper I referred Tropacarus as a subgenus of Steganacarus. After having examined specimens kindly sent me by F. Grandjean, I am now of the opinion that this species is distinct enough to warrant its being given generic rank.

Thus the more primitive genus Phthiracarus shows considerable variation or groping about in its bristle arrangement, while in the more advanced Hoplophorella and Steganacarus the arrangement has become more set. Likewise one finds that bristles II:2 become specialized in form and stature in these two genera, as well often as the notogaster bristles.

Hoplophorella cucullata (8, p. 133, pl. 6, fig. 35) *comb nov.*

Diagnostic characters: Body rather small (abdomen 0.48 mm. long); oval; greenish grey, yellowish brown where chitin is thicker; sculptured by pockmarking; aspis with broad, squarish (angular) ridge (figure 20); a distinct, angular, flattish, transverse constriction at base of vertical and lateral bristles; carina thrown out to form a conspicuous lateral ridge, leaving a pockmarked area between ridge and carinae; rostral bristles very small, inserted at distal end of ridge, i.e. far above rim of aspis; vertical bristles very short, straight; pseudostigmatic organs long, slender, curved, the edge turned forward, finely rough serrate along distal half; notogaster bristles spoon-shaped, that is with a flattened handle (pedicel) and hollow, bowl-shaped distal portion; genital covers strongly longitudinally constricted (indicated by crenate line in figure 18, undulate line in figure 20); anal cover bristles II:2 broad, blade-like, curved backward near apex, the other bristles fine.

This is a well differentiated species which shows much variation. The variations seem to be locally constant enough to form local races or subspecies.

Hoplophorella licnophorum (4, p. 102, pl. 8, fig. 99) is this species, as it was also described from Columbia, Missouri, and has the same size and characters. The figure shows *angular* areolations of some depth. The holotype of *H. cucullata*, kindly loaned me by Dr. Ewing, has somewhat angular areolations but the areoles are more open, separated by narrow, round shouldered ridges. The coarsest of the Floridian specimens (as no. G75P12) have deep, clean cut, rounded pockmarks with interspaces as wide as the pocks. The holotype of *H. cucullata* has pockmarks on the aspal ridge and in the area between the ridge and the carinae. The Floridian material shows a considerable tendency to lose the pocking and become very thinly chitinized. Anal cover bristle II:2 is figured in *H. licnophorum* as being similar to the other anal cover bristles (!), thus making it similar to the European species (Steganacarus). This is quite certainly erroneous. The holotype of *H. cucullata* is, compared with Floridian specimens, very coarsely sculptured and ridged. For instance the notogastral hood is even higher than in figure 22. The aspal ridge is higher. The carina is highly developed, appearing more like a keel, the upper (dorsal) edge of which is represented by another line parallel to it. Thus there is quite a hollow between the ridge and this carinal keel. I therefore designate the Floridian race as:

7. **Hoplophorella cucullata cuculloides** *subsp. nov.*

Figure 22

Diagnostic characters: Size smaller; pocking more clean cut, of smaller caliber, of rounder pits, stippling strongly developed; aspal ridge not so prominent; carinae much less developed, not forming conspicuous ridges; notogastral bristles relatively longer; anal cover bristles II:2 longer.

Thus this form is dominated by a less degree and less intense development of ornamentation (ridges, sculpturing) but greater bristles.

Dimensions (of only three measurable specimens):

Length of notogaster, 332(362)390; of aspis, 176(179)197
Height of same, 180(207)226; of aspis, 74 (83) 90

The holotype of *H. cucullata*, which is very oblique and shattered, has a notogaster 450 by 275.

Occurrence: Milton (one specimen: G62), Gainesville (three specimens from two lots: G6, G75-*Cotypes*), Bonita Springs and Villa Tasso (one specimen each: G95, G101). Thus most of the stations are in west Florida.

H. hamata (8, p. 134, pl. 6, fig. 36) is also one of these subspecies, characterized by entire absence of hood. The "small chitinous band" of the original description is the collar, for the holotype, kindly loaned me by Dr. Ewing, has no hood whatever. The pockmarks are more distinct (see figure) than in the species, including some on the aspis also. These pockmarks are similar to the Floridian *H. cucullata*, i.e., barely angular, deep, and separated by interspaces nearly as wide as the pockmarks. The holotype is mounted obliquely so that nine or ten bristles stand out above the outline of the notogaster. Careful focusing shows these to belong to rows I and II of the further side. Thus there is the usual number of bristles. Furthermore the animal looks long and narrow because of the way it is mounted and viewed. If mounted squarely on its side it would undoubtedly be found to have a more normal length-height ratio. This type specimen differs from the Floridian material in being considerably larger, darker (the Floridian specimens being quite greyish), sculptured with deeper pockmarks and smooth interspaces. I therefore describe it in detail under the name:

8. **Hoplophorella cucullata floridae** *subsp. nov.*

Figures 18–21

Diagnostic characters: Body smaller (abdomen averaging 0.38 mm. long); notogaster *stipple-punctate*, with weakly punctate pockmarkings

which are almost to quite evanescent on *certain* areas of the aspis, genital and anal covers; thinly chitinized individuals show very faint to no pocking—though *the stippling remains quite evident*; no elevated hood on median area, though it is present on the *sides* in all the specimens which I rolled over (see figure 20, which had no indication of a hood in lateral aspect!). Moreover, it is slightly developed in a few specimens (figure 21). It should be noticed that this elevated hood is much more extensive than the collar. Bristles I:1 in both cases originate at the posterior edge of the collar, thus being set well onto the hood when developed. Because of these intermediate specimens and the fact that the hood is developed on the sides of the notogaster without being continuous over the dorsum, I cannot consider the development of this hood as of generic or even specific rank. All intergrades occur! In the material before me, however, most of the specimens are unhooded on median area. On the other hand there are more specimens with a well developed hood on dorsum than with a weakly developed one. Furthermore, this development of a large hood is accompanied by deep, large pockmarks and longer bristles so that two races are distinguishable. A careful study of this hood in its various stages of development shows that it originates as a constriction about the notogaster, followed by a thrusting *forward* and inward of the constriction so as to make the constriction almost underlie the hood as a groove (figure 22, which also shows the deeper corrugation of the posterior portion of the aspis). This constriction thus almost becomes a fold.

The arrangement of the bristles in the earlier descriptions is inaccurate. I find it difficult to locate them all with care even with the twenty specimens at hand. The aspal bristles are not mentioned in the old descriptions but I find, from Ewing's types, that they are as figured on my third plate. Vertical bristles more approximate than notogastral I:1; notogastral bristles I:2 and I:3 slightly more remote than I:1; I:4 and I:5 slightly more remote than I:2 and I:3; II:1 very close to collar. I note that the ventral plate if looked at from ventrolateral aspect appears *below* insertion of VP:1 to 3, from which I infer that it flares inwardly of the notogaster.

Dimensions (of eleven measurable specimens):

Length of notogaster,	336(382)426;	of aspis, 172(192)209
Height of same,	172(213)252;	of aspis, 65 (82) 98

The loss of size with decreased latitude is a common phenomenon.

This species so very much resembles *Hoplophthiracarus histricinum*

in size, color, and texture that some individuals of both species were mounted on the same slide and I at first took them for the same species.

Occurrence: Gainesville (six specimens from three lots: G6, G29, G75-*Cotypes*), St. Augustine (one specimen: G34), Palatka (two specimens: G69), Crescent City (one specimen: G82), White City (two specimens: G108), Bradenton (seven specimens: G87), Bonita Springs (one specimen: G95). Thus from seven localities (out of forty-three) all are from the eastern side of the promontory except two. This subspecies has not therefore been secured from west Florida. Both subspecies are found in the same lots from Bonita Springs and Gainesville. This is undoubtedly due to carriage (anthropophory) at Gainesville but how about Bonita Springs?

9. **Hoplophorella varians** *sp. nov.*

Figures 23–25

Diagnostic characters: Size varying in abdomen length from 0.54 to 0.87 mm.; color brownish; surface strongly areolated; rostrum conspicuously protruding, with quite evident bristles; transverse sulcus across aspis quite marked, vertical bristles too low down on sides to be visible in lateral aspect; pseudostigmatic organs relatively short for this genus; anterior edge of notogaster strongly turned down so that collar is almost vertical; notogastral bristles stout, distal third usually thicker, I:1 often depressed; anal covers strongly and angularly produced along median edge, bristles II:2 stout, long, lance-like, I:1, I:2 and II:3 rather short, rather widely spaced for the genus.

Dimensions (of ten measurable specimens):

Length of notogaster,	543(681)833;	of aspis, 295(353)427
Height of same,	307(400)532;	of aspis, 127(147)168
Breadth (one average indiv.),	480;	246

As the proximal end of the aspis is often covered by the opaque notogaster, I add here length of aspis to the anterior edge of pseudostigmata: 197 (229) 303. I find that in this species oblique length and horizontal (= what?) length are, for all practical purposes, equivalent. The *notogaster* is broader than high but as the genital and anal covers are often fully opened out, thus giving the abdomen much greater height, the animals usually lie on their sides in balsam mounts.

Description: Aspis, seen from side, relatively high (figure 23) with prominently drawn out rostrum, and angular transverse sulcus between

pseudostigmata; seen from above, rapidly narrowing from pseudostigmata; ridge well developed, broad, angular, slightly lower along median line (figure 24); rim slender, not projecting beyond rostrum; carina weakly developed; accessory plate notches distinct, angular; rib short, stout, curved; rostral bristles fairly well developed, inserted far down but remote; vertical bristles short, straight; pseudostigmata with a distinct, broad lid, curving over the more or less seven-scalloped cup; organs angularly bent, fairly stout (as stout as notogastral bristles), thickening towards distal end; sculpturing absent between ridge and sides of aspis, and below carinae, posterior part of aspis with areole ridges straightening out to form slightly radiating ridges.

Notogaster, seen from side (figure 23), elongate oval, fuller than in most species, with the anterior edge turned downward and inward so that the collar is nearly vertical, and forming a rounded angle with dorsal face, this constituting one of the outstanding characteristics; collar not prominent; lapet large, areolated, though not always distinctly so; bristles stout, slightly roughened and thickened towards blunt distal end, I:1–5, II:1–4, III:1–3; I:1 distant from collar, often lying close to notogaster and then shorter and with tapering distal end (in two specimens out of twenty, these bristles resemble the others, and in two or three the bristles are intermediate); some of the bristles of rows II and III, especially the anterior ones, are also bent (figure 24), while bristles II:1 are similar to I:1. Because of the areolation and opacity of the chitin it has been difficult to make these lateral bristles out with certainty; II:1 are unusually distant from collar; I:1 slightly more remote than vertical bristles; I:2 and I:3 slightly more remote than I:1; I:4 almost as approximate as I:3; VP:3 more approximate than I:1. Ventral plate very wide behind, bristles VP:1 slender and inserted well down on sides, VP:2 less so, VP:3 near margin, all three *usually* bent down close to body though they may also be erect. In one individual VP:3 is erect on one side, and slender and depressed on the other! In some individuals VP:3 may be erect while I:1 is depressed. Nubbins well developed. Accessory plate quite prominent in side view (figure 23). Genital covers about as long as anal, anterolateral corners well drawn out, anterior margin rendered undulate by a convex lobe near lateral angle (figure 24), areolated as coarsely as notogaster, though indistinctly so along lateral portion; bristles distinct, though fine, two erect ones on anterior edge (or on accessory plate) (figure 23), three bent ones on median edge and three on anteromedian corner, one of them stouter and inserted well around on to face of cover; center of median

edge of anal covers prominently drawn out so as to form an angle with the posterior edge. In ventral aspect there appears a distinct tooth along this posterior edge (figure 24) which I do not remember seeing in other species, one behind the other; posterior edge also drawn out into a slender ridge which fits into the notch between the denticles, thus preventing tortion and insuring accurate closure; areolation lacking on lateral half, especially posteriorly; bristles fine, rather short, curved backward, rather distant from each other, II:2 specially developed (see under diagnostic characters); median corners highly diversified by development of flanges and flattened teeth in three planes. In figure 25 the outermost plane is drawn with a heavy line, the innermost by a light line, while the intermediate plane, which is usually a tooth or recess, is drawn by a fine line or a dotted line if a recess. Thus the left cover has its corner well drawn out into a long, rectangular, hook-like tooth which fits under the right anal cover and under the right genital cover. The inner flange of the right anal cover is short but drawn out into a prominent triangular, corner tooth. The inner flange of the genital covers is quite long on the posterior edge, but highly undulate on the median edge. In the figure the anterior edge of the left cover is broken away (jagged line). A consideration of this highly complex interlocking region convinces me that these four covers must open and close *together*. Thus in the Euphthiracarini the fusion of the covers of the left side and the fusion of those of the right side to make one cover on each side instead of two is an economy.

From the above it should be evident that this species is quite distinct from any other of the eastern coast and easily recognized.

Occurrence: Gainesville (fifteen specimens from five lots: G29, G30, G75, G76, G84), Pinkoson Springs (one specimen: G33), Orange Heights (one: G48), Micanopy (one: G74), St. Augustine (six out of two lots: G21, G63 = *Cotypes*), Vero Beach (one: G67), White City (three: G108), Cortez (two: G45). Thus the distribution is chiefly eastern; no specimens were taken from southern and western Florida. Those from Orange Heights were taken from spruce-pine needles and small limbs from ground of burned land, the others from various kinds of fallen leaves, from palmetto scrub to shore bay débris. Therefore the species is to be found in a wide variety of leaf mould and at any season.

Hoplophorella cucullata floridae X varians

Five specimens from White City are identical in appearance and are perfect hybrids. They have the following characters of *H. cucullata*

floridae: color, sculpture, shape of bristles of notogaster and anal covers; and of *H. varians:* size, shape of notogaster, genital and anal covers, place of insertion of rostral bristles and of notogastral bristles I:1 and II:1 (as also of the others). Of intermediate nature are: shape of aspis which has the height of *H. varians* but not the rostrum, though the anterior end is oblique—a combination of the two species. The hybrid has distinct aspal carinae extending to accessory plate notch (in the parent species it was short and poorly developed); the rostral bristles are anomalous: short, strongly curved, flattened blades (sickle-like) usually pointing upward, sometimes asymmetrically (like horns of mongrel cows). The vertical bristles are longer than in either parent, stout, rod-like, pointed—much like a lead-pencil but bent toward aspis near apical end. They seem to be inserted distad of transverse sulcus and are quite visible above the aspis in side view; the pseudostigmatic organs are not sharply curved, but undulate, compressed, the distal portion directed forward! The anal covers are sometimes less markedly angular than *H. varians* but just as much drawn out.

To summarize, there are characters distinctly of one parent species, notably the shape of the abdominal bristles, and characters distinctly of the other parent species as the shape of the plates of the abdomen, while some are quite different even to the extent of such unknown rostral bristles which stick out above the aspis like the tusks of a boar. Although both parents occur in the same lots from Gainesville and St. Augustine, this hybrid was secured only at White City, near the southern limit of the range of the parent species. Is this a result of temperature? In the same lot with the hybrids occur two normal *H. cucullata floridae* and three normal *H. varians.*

Tribe EUPHTHIRACARINI (17, p. 241)

Genus **Pseudotritia** (17, p. 242)

10. **Pseudotritia ardua** (18, fasc. 32/15)

As this species has already been figured and described in detail (17, p. 243, pl. 38, figs. 44–51, and pl. 35, fig. 25), only data pertaining to Florida is added. In form this species is typical but it averages smaller.

Dimensions: The figures are taken from nineteen specimens, fifteen of which come from Pinkoson Springs and four (quite within the size range of the Gainesville specimens) from Pensacola.

Length of notogaster, 444(479)554; of aspis, 222(236)254
Height of same, 275(300)345; of aspis, 82 (91)103

This average is lower than that of Connecticut specimens, in spite of the fact that the smallest is much larger than the smallest from the northeastern states. Of the twenty-two measured individuals only two were without eggs (presumably males, being near the lower size limit). An individual from Key Largo, larger than the largest Gainesvillian, measures 566, 373; 262, 98 (microns).

Occurrence: Pensacola (four specimens: G61), Gainesville (five specimens from three lots: G6, G77, G109), Pinkoson Springs (twenty-three: G33), Mulberry (one: G103), Key Largo (one: G92). Thus no specimens were secured from the west coast of the peninsula.

Three specimens with a notogaster length of 373 microns, have but one hook to the unguis of legs IV. This is a type of mutation not yet encountered and, if such mutations should receive designatory names, I would call this one **P. a. antetriheterodactylum** *mut. nov.* Thus we have the following combinations:

P. a. monoheterodactylum with one hook on tarsi I–III; three on tarsi IV.
P. a. triheterodactylum with one hook on tarsi I; three on tarsi II–IV.
P. a. antetriheterodactylum with three hooks on tarsi I–III; one on tarsi IV.

The cotypes of this new mutation are on slides G33P3, P5, and P7 (one specimen on each).

11. **Pseudotritia ardua sinensis** (15, p. 178)

Diagnostic characters: Ungues monohamate.

As this form is differentiated by only one character it is a mutational variation rather than a subspecies (geographical race).

Eight specimens from Pinkoson Springs measure:

Length of notogaster,	398(450)493;	of aspis,	202(208)229
Height of same,	262(281)303;	of aspis,	82 (87) 94

Thus averaging very slightly lower than the species (found in the *same lot*). Fifteen specimens from Gainesville measure:

Length of notogaster,	406(480)574;	of aspis,	205(234)264
Height of same,	262(313)365;	of aspis,	82 (93)106

Thus being practically of the same size as the Pinkoson Springs heterohamate specimens. In other words we have before us specimens with only one hook to the unguis, *living among* individuals with three hooks, and with others that have one hook on some legs and three hooks on the

other legs! Yet Willmann (23, pp. 189 and 194) maintains Pseudotritia as a separate genus for species with only one hook.

Seven specimens from Milton (near Pensacola) measure:

Length of notogaster,	389(443)472;	of aspis,	205(228)242
Height of same,	234(278)291;	of aspis,	74 (89) 98

Thus, like the Pensacola specimens of the triheterohamate form, averaging smaller than the Gainesville individuals.

Four specimens from Vero Beach, and four from White City measure:

Length of notogaster,	467(518)574;	of aspis,	235(254)266
Height of same,	316(344)369;	of aspis,	97 (99)111

Thus, like the Key Largo heterohamate specimen, averaging larger than the Gainesville individuals.

After plotting these various measurements on coördinate paper I find they show remarkable similarity, i.e. the lines are so nearly parallel that I can say there is no modification in proportions. Moreover the addition of the corresponding figures for the *P. sinensis* specimens from China, show such slight difference in proportion as to make the difference barely of academic interest.

In this connection it is significant that in the family Protoplophoridae (9) the larger species have three hooks, while the smallest has but one.

A careful survey of this data, what with my data on the material from the northeastern states, convinces me that these differences in number of hooks on the ungues is of no significance in this species, and are of no systematic interest. It only remains to be determined whether the occurrence of the number of hooks follows Mendelian laws of inheritance. I doubt whether anything is to be gained by separating the monohamate and trihamate specimens—especially in Florida where the two are found in the same lot and of the same size.

Occurrence: Milton (eleven specimens: G62), Madison (one: G23), Perry (two: G10), Mayo (six: G11), Wellborn (one: G115), Gainesville (one hundred and six from twelve lots: G6, 25 specimens, G11, 6, G13, 4, G29, 10, G30, 29, G54, 1, G55, 1, G75, 9, G76, 3, G84, 2, G90, 3, G116, 19), Pinkoson Springs (eleven: G11), Micanopy (five: G28, eight: G74), Green Cove Springs (nine: G80), St. Augustine (one: G21, two: G35), Palatka (two: G69), Crescent City (two: G82), Eustis (one: G105), Mulberry (one: G103), Vero Beach (five: G67), White City (five: G108), Villa Tasso (eight: G101). Thus the distribution in

Florida is quite general but does not extend onto the west coast, as at Bradenton, Cortez, and Bonito Springs. This monohamate form was absent from both the moss samples (from Gainesville), but present in numbers among damp leaves. It seems to avoid pine-spruce needles, for instance it was absent from lots G48 and G61, and but one specimen occurred in lots G54 and G62. It is noteworthy that the monohamate form is by far more abundant than the heterohamate.

Genus **Oribotritia** (16, p. 167)

Characters: Usually large and broad species having bristles absent to medium long (rarely if ever as extremely developed as in the genus Euphthiracarus); aspis usually very long, through extension of the lower part of the abdomen; carina usually well developed; rib fairly well developed; lid usually above pseudostigmata; pseudostigmatic organs usually quite small and fine; median ridge absent; anogenital area often quite narrow but deeply infolded so that detail is best seen in oblique aspect, the bristles much reduced, VP:1 represented by a minute insertion, no interlocking series of ridges; both anal rods and genital shields present; anogenital plates with or without diagonal slit; legs long with stout bristles, the tarsi armed with three hooks, of which the outer are longest; palps with three or four free joints; eggs numerous, slender; not extending as far north as preceding genera.

12. **Oribotritia glabrata** (22, p. 73)

Figures 26–29

Diagnostic characters: Size varying in length of abdomen from 0.58 to 0.91 mm.; color dark tan to chestnut brown; texture finely sanded; pseudostigmatic organ head blade-like with slender pedicel (figure 28), seen from above one sees only the back or edge of the blade (figure 27). In figure 26 it is shown foreshortened below the aspis and end on in the lateral aspect. Bristles long, fine, prone; vertex bristles unusually remote, and close to pseudostigmata; rostral (?) bristles on transverse plane proximad of lateral (!); lateral bristles unusually far from pseudostigmata and close to carinae; notogastral bristles III:1 unusually close to II:1, III:2 also unusually high up on sides; III:3 almost between II:4 and VP:2; VP:3 far from posterior end of abdomen.

Dimensions (of five measurable specimens):

Length of notogaster,	578	(820)	913,	of aspis,	314(407)467
Height of same,*	365	—	—;	of aspis,	119 — —
Breadth of same,**	—	586	—;	of aspis,	— 320 —

* of one unusually small specimen
** of one medium sized specimen

Description: Aspis unusually broad at anterior end (figure 27), with a distinct carina; posterior border thickened, curved distad to project ectad of pseudostigmata as a shelf *below* them; rim slender, projecting beyond sides of carinae; no discernible lid; pseudostigmatic cup with about eleven radial sectors visible from side, the largest on proximal side.

Notogaster (figure 26) narrower than high, seen from above or the side bluntly angled behind, high in front; collar narrow; notch very open, merely an undulation; lapet long, slender; bristles very fine, I:1 rather distant from collar, I:5 low down, on ventroposterior angle, III:1 also distant from collar, at least more so than II:1 and unusually close to it, III:3 close down to VP:2, thus III:2 and III:3 are quite remote, VP:3 distant from posterior end of abdomen.

Genital shields with but six pairs of bristles evident, strap-like, i.e., as broad anteriorly as posteriorly; the two bristles on each anogenital plate inserted far forward, the anterior one almost on rim; anal rods with two pairs of bristle insertions, one on head the other (bearing a long, fine bristle) on transverse plane between rudimentary VP:1 and VP:2; two pairs of bristles on rim of anal section of anogenital plates, one pair on transverse plane between VP:2 and VP:3, the other bearing a slender bristle on transverse plane closely posteriad to VP:3. The posterior pair of anal rod bristles and the anterior pair of the anal section of the anogenital plates are caducous and seldom seen. An individual with a break across the anterior part of the genital field shows that the lower edge of the notogaster (represented by a heavy line in figure 29) is rounded or bluntly folded upward and inward, and that the edge of the plate meets the edge of the anogenital plate at a very acute angle, evidently being connected by a thin membrane. Figure 26 is that of a small, pale individual, the only one out of the dozen specimens not mounted obliquely.

Occurrence: Gainesville (five specimens from four lots: G6, G75, G109, G111), Edgar (near Hawthorne), Green Cove Springs (one specimen each: G80, G81), Bradenton (three: G44), Cortez, White City

(one each: G45, G108). Thus from both the east and the west side of the peninsula though not from the west or south ends of the state. One specimen was from "true moss," the others from various fallen leaves. Say's specimen came from "Georgia and east Florida."

Identity: This species is referred to Say's name because it is the commonest species of this genus. It is true that Say gives no characters of generic value. The only specific characters given are: glabrous, black, under stones. It is evidently fairly frequent and probably large enough to be fairly easily seen. No species of Floridian Phthiracarid is glabrous. Say undoubtedly could not see the extremely fine bristles which are visible only under high magnification and special illumination. There are no black species of Phthiracarini, in fact these species are usually quite pale. *Ph. sphaerulum* has an abdomen 0.4–0.8 mm. long, so that the present species averages slightly larger. Furthermore the present species though a rather dark brown by transmitted light is probably quite dark in life. I know of no Phthiracarids that are black or blackish. Steganacarus and Hoplophorella are the darkest of the Phthiracaridae but these have very stout and conspicuous bristles. *Pseudotritia ardua*, the commonest Phthiracarid, is quite compressed and pale in life color. Thus every indication is toward the present reidentification. Say's specimens are not at the Philadelphia Academy.

13. **Oribotritia carolinae** (17, p. 257, pl. 42, figs. 73–76)

Figures 30–32

Diagnostic characters: Size fairly large (length of abdomen 0.85 mm.); color amber; texture finely sanded; anterior rim of aspis strongly retracted; pseudostigmatic organs rather long, flagellar; bristles short, erect, vertex bristles distant from pseudostigmata and on transverse plane distad of them; lateral bristles close to carina and far from pseudostigmata; two carinae; lid very well developed; VP:3 at posterior corner of abdomen; bristles of anal area rarely present.

Dimensions (of five specimens):

Length of notogaster,	800(851)891;	of aspis,	345(399)425
Height of same,	552(578)611;	of aspis,	— 145 —
Breadth of same,	— — —;	of aspis,	— 272 —

These measurements reveal an unusually short aspis compared with height of notogaster. This is due to the great depression of the notogaster anterior to its center and again above the aspis.

Description: Aspis sanded between pseudostigmata, smooth below carinae; rather small, anterior end strongly contracted to form a distinct rostral area (figure 31), posterior edge with a stoutly thickened, very slender, chitinous rim, and a much thinner, broad band; rim projecting beyond carinae; the upper carina is blunt, the lower sharp, fine; anterior and lateral slope marked by fine, undulate combing, more marked than in *O. banksi*; rostral bristles quite close, their insertions strongly marked; although the two pairs of posterior bristles in figure 31 seem to be inserted far more distad than in figure 30, both are camera lucida tracings and therefore the difference is due to angle of vision on these curved faces.

Notogaster seen from side (figure 30) very much curved, anterior profile descending rapidly, similarly to posterior, then bending down again above aspis, lower edge of posterior end also constricted; collar narrow; notch very deep; lapet very slender, very oblique, lower end tapering to a point; bristles rather short, rather fine, curved, I:1 far from collar, I:5 so high up as to occupy the place usually held by I:4, thus the whole row much more crowded than usual, II:1 correspondingly distant from collar, II:4 correspondingly high up on sides, III:1 in the very marked angle of the lapet, thus very low down and anterior, III:2 also low down on sides and on transverse plane between II:1 and II:2, VP:2 somewhat more posterior than usual. Thus the whole bristle arrangement is quite different from *O. banksi* which it resembles in aspal sculpture, and in lateral profile of notogaster (except the lapet).

Anogenital area quite slender; anogenital plates closing genital area over quite completely then cut back sharply to sides of opening and gradually covering over posterior three-fourths of the anal area. Thus the genital shields are completely covered; anterior edge strengthened by a projecting band of chitin (figure 30); a single pair of bristles inserted near ental edge of plate not far from anterior end (figure 30); a diagonal slit along sides, originating at lateral angles (figures 30 and 32); a pair of bristle insertions at posterior third of anal section. Genital shields covered over by genital plates; the bristles present, inserted on a slender rib; anterior edge thickened. Anal rods with faint bristle insertions on head, no other insertions discernible, median edge thicker and twisted in at least two places (posterior twist only shown in figure 32).

Palps three segmented, but proximal segment has a faint, pale ring about it where joint of the second would normally be (they appear to be four segmented in the original figures).

Occurrence: White City (five specimens: G108) and Fort Lauderdale (one specimen: G113), thus both from the southeast coast. The cotypes came from the Black Mountains of North Carolina and are not before me for comparison.

FREQUENCY OF OCCURRENCE

In the following table, the 258 specimens collected are referred to their respective species and genera. The numerals in parentheses record the number of lots in which each species was found.

Aedoplophora major	4	(1)	genus 4
Hoplophthiracarus histricinum	22	(5)	
Hoplophthiracarus robustior	14	(1)	
Hoplophthiracarus grossmani	2	(2)	genus 38
Phthiracarus sphaerulum	12	(7)	
Phthiracarus prior	4	(2)	genus 16
Hoplophorella cucullata floridae	20	(9)	
Hoplophorella cucullata cuculloides	6	(5)	
Hoplophorella varians	30	(13)	
Hoplophorella cucullata X *varians*	5	(1)	genus 61
Pseudotritia ardua	34	(7)	
Pseudotritia ardua sinensis	187	(28)	genus 221
Oribotritia glabrata	12	(9)	
Oribotritia carolinae	6	(2)	genus 18

Thus the commonest species, arranged in order of abundance, are: *Ps. ardua sinensis, Ps. ardua, H. varians, Hph. histricinum, H. cucullata floridae, Hph. robustior, Ph. sphaerulum, O. glabrata.*

Of the forty-three lots, eleven yield only *Ps. ardua sinensis.* Only twelve lots yield three or more species. Lot G108 (White City) contains the largest number of species (seven), namely: *Ph. sphaerulum* (1), *H. cucullata floridae* (2), *H. cucullata* X *varians* (5), *H. varians* (3), *Ps. ardua sinensis* (5), *O. glabrata* (1), *O. carolinae* (5). Lot G75 (Gainesville) has six species much as the above; and G33 (Pinkoson Springs) also yields six: *Hph. grossmani* (1), *Ph. sphaerulum* (1), *Ph. prior* (3), *H. varians* (1), and *Ps. ardua* and variety (34). Fourteen lots from Gainesville net eight species.

By contrast, eleven species, seven of them belonging to the genus Phthiracarus, have been taken from one locality in Connecticut. Some of these are possibly introduced from Europe. Two are found in Florida, *Ph. sphaerulum* and *Ps. ardua.*

ECOLOGICAL DATA

Of the three important niches occupied by Phthiracarids, decaying wood, moss, and leaf mould, in the present collection the first niche was entirely overlooked and the second is represented by only two lots. This collection lends itself, therefore, to a study of the preference and restriction of box mites to particular kinds of leaf mould.

From seventeen different kinds of leaves, and of various degrees of dampness and dryness, one must draw the conclusion that these mites are quite impartial to the kind of leaves they find, except that they are not abundant or even common among pine and spruce leaves (with the exception of lot G61 where thirteen specimens of *Hph. robustior* were found). Lot 33, bearing six species, two of them uncommon, might seem to favor hickory leaves but *Ph. prior* was also taken from live oak leaves and *Hph. grossmani* was also secured from shore bay debris. Thus there must have been other factors which made locality G33 a favorable one.

A careful study of the species under each lot reveals rather that such extreme niches as those of lots G21, G23 (pine), G28 (cultured), G34, G35, G48 (burned land, spruce and pine), G54 (pine), G55 (pine), G81 (too new), G84 (too dry), G90 (too dry), yield but very little, usually one specimen of *Ps. ardua sinensis*. Lots of dry leaves inevitably yield few specimens of the most frequent species. Lots from shady and moist niches give most species and individuals. Undoubtedly the most undisturbed land, with plenty of leaf mould, will make the most interesting collection. In brief, extreme conditions, as sea oats on the sandy beach, or dry, sunny pine land, do not yield specialized species, but the most tolerant species—in this subfamily.

An attempt has been made to correlate the occurrence of species with soil types (12) but without success. No attempt has been made to correlate distribution with the types of vegetation (10, 11, 13) which would only affect local occurrence (6, p. 290). For such correlations, collecting would have to be carried on with this object in view.

GEOGRAPHICAL DISTRIBUTION

The distribution of the different species may be visualized by means of the following table:

Aedoplophora major.....south tip
Hoplophthiracarus histricinum.....w. and w. coast

Hoplophthiracarus robustior	w. Fla.
Hoplophthiracarus grossmani	peninsular
Phthiracarus sphaerulum	peninsular
Phthiracarus prior	northcentral
Hoplophorella cucullata floridae	peninsular
Hoplophorella cucullata cuculloides	w. and w. coast
Hoplophorella varians	peninsular
Hoplophorella cucullata X *varians*	e. coast
Pseudotritia ardua	except w. coast of pen.
Pseudotritia ardua sinensis	same
Oribotritia glabrata	peninsular
Oribotritia carolinae	e. coast

Thus, as far as we now know, there is one species confined to the southern tip, two to the east coast, one to northcentral, one to extreme west Florida. Five are peninsular, two are found along the west coast, two are found throughout Florida though not yet on the west coast.

The holarctic *Ps. ardua* is found from end to end of the state even to Key Largo. The New England *Ph. sphaerulum* is found almost throughout the peninsula. The Mississippi valley *Hph. cucullata* is also found as a variety throughout the peninsula. *O. glabrata*, extending from the southern edge of Connecticut, is also peninsular.

One wonders why the commonest form, *Ps. ardua sinensis*, is not found on the west coast of the peninsula, though found in extreme west Florida? *H. cucullata cuculloides* being found along the west half is more closely related to the species than *H. cucullata floridae* which I do not find from west Florida. These two subspecies overlap.

Although our knowledge of the West Indian and central American species is extremely meagre, one can definitely state that *Aedoplophora major* is of tropical abstraction being very closely related to *Ae. glomerata* of Venezuela, and that no other species seem to have tropical affinities. On the other hand six species are definitely known to extend far to the northward. This ratio of geographical affinities corresponds fairly well (remembering the regrettable state of our knowledge of this group) to that for the Odonata (6, p. 271) which is:

Nearctic	about 60%
Neotropic	23%
Endemic	17%
Found in Connecticut	35% (25% for box mites)
Found in Indiana	42% (unknown)
Cosmopolitan	14% (two out of thirteen)

Temperature was judged to be the most important factor influencing distribution in the Odonata (6, pp. 292–300), and the state was divided

into three or four sections on this basis. This has been reproduced in text figure 1. The broken lines are the isotherms for 54°, 61° and 66°, the average temperature for January. The distribution of the Phthiracaridae does not seem to correspond to this factor but rather to physiography.

As Florida has been a peninsula from Miocene time, it has had far more time to become populated than glaciated New England, yet its box mite fauna is more meagre. It is impossible at present to state if evolution has gone further.

ITHACA, N. Y.

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EXPLANATION OF PLATES

PLATE 19

Aedoplophora major *sp. nov.*, adult

Fig. 1. Pseudostigmatic organ head; free hand.
Fig. 2. Lateral aspect, pygidium almost completely retracted, only distal part of one foot included, mouth parts omitted; ratio 200.
Fig. 3. Anterolateral rim of pronotaspis showing collar; ratio 200.
Fig. 4. Ventral aspect, slightly oblique, appendages omitted; ratio 200.
Fig. 5. Aspis, slightly oblique; ratio 200.
Fig. 6. Pleuraspis, ectal view (ridges indicated by broken lines), with an anal cover (the underlying parts outlined by means of dotted lines); ratio 200.
Fig. 7. Anal covers seen obliquely with articulation arm passing under apodeme flange; ratio 200.
Fig. 8. Edge view of an anal cover showing articulation arm; free hand.
Fig. 9. Distal three segments of palp; ratio 440.

PLATE 20

(All figures are of the same magnification, with legs and mouth parts omitted).

Phthiracarus prior *sp. nov.*, adult

Fig. 10. Lateral view.
Fig. 11. Dorsoventral.

Hoplophthiracarus grossmani *sp. nov.*, adult

Fig. 12. Lateral view.
Fig. 13. Dorsoventral; the pseudostigmatic organs broken.

PLATE 19

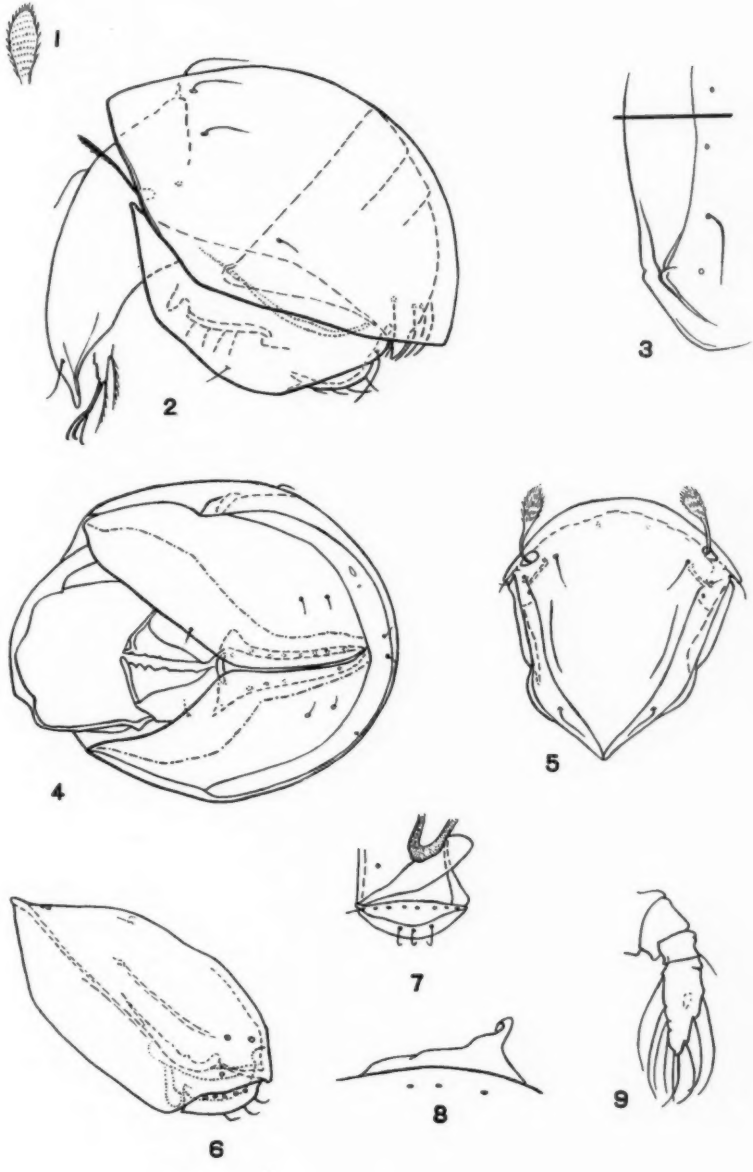
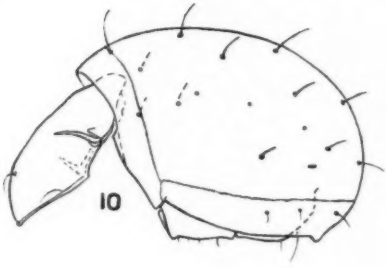
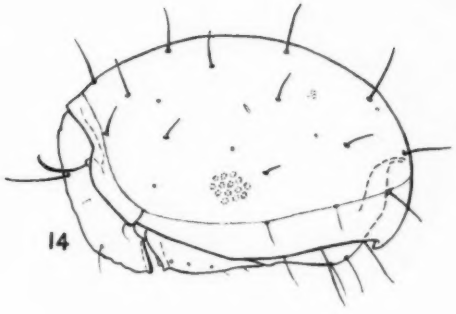
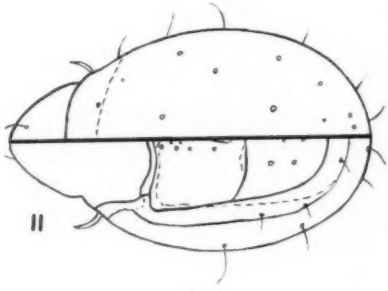
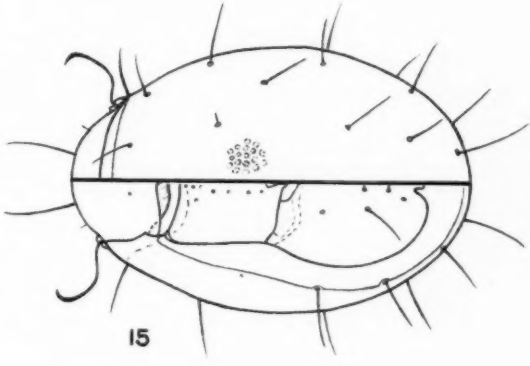


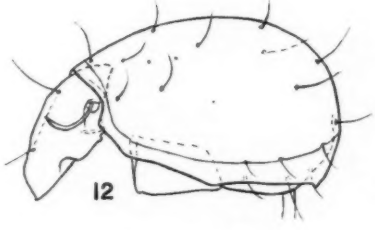
PLATE 20

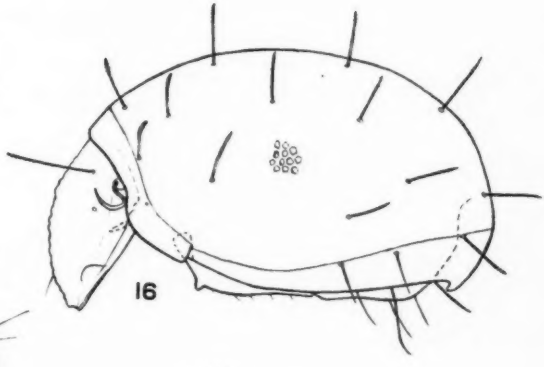












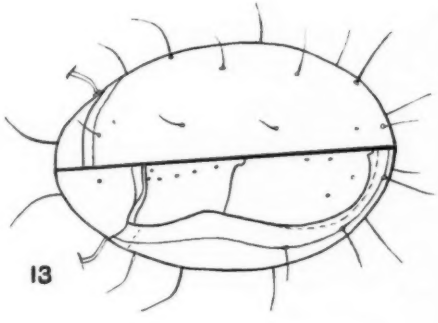


PLATE 21

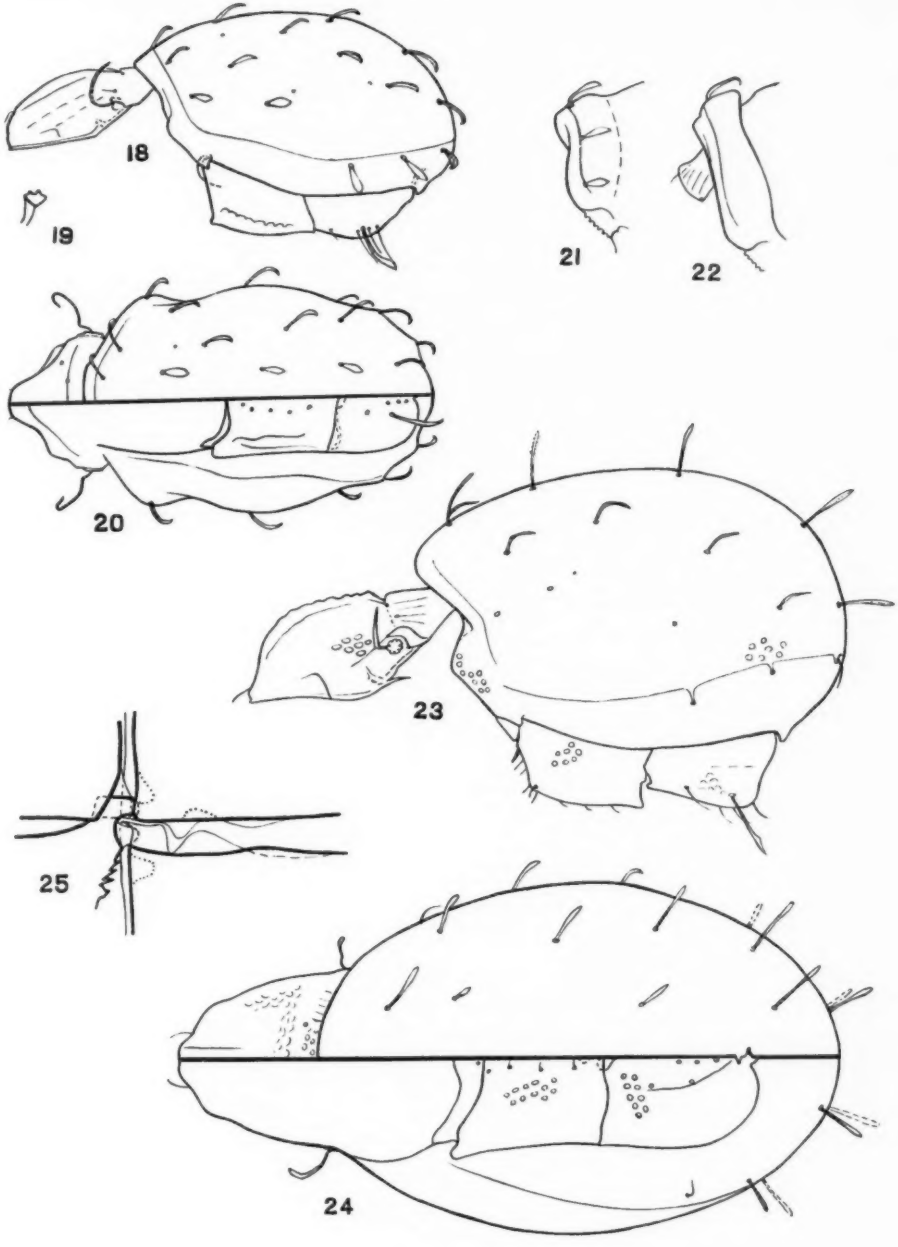
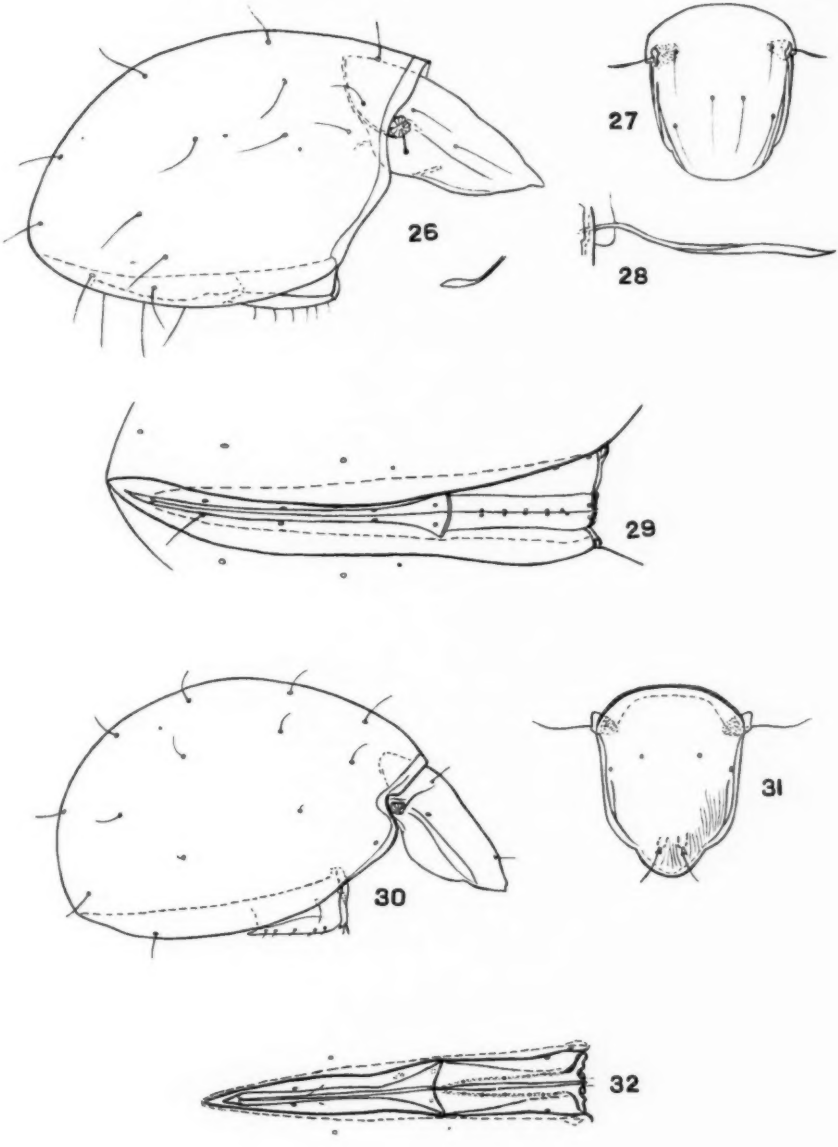


PLATE 22



Hoplophthiracarus histricinum (2, p. 12), adult

Fig. 14. Lateral view; nearly closed.
Fig. 15. Dorsoventral; crosshatched area is the opening between aspis and accessory plate.

Hoplophthiracarus robustior *sp. nov.*, adult

Fig. 16. Lateral view.
Fig. 17. Denticles and notch of ventral plate, viewed at right angles to plate.

PLATE 21

Hoplophorella cuculiata floridae *subsp. nov.*, adult

Fig. 18. Lateral view, legs and mouth parts omitted; ratio 100.
Fig. 19. Notogastral bristle seen from end, showing two carinae on dorsal face; free hand.
Fig. 20. Dorsoventral view; ratio 100.
Fig. 21. Anterior end of notogaster of a specimen with low hood; ratio 100.
Fig. 22. Anterior end of notogaster of a specimen with high hood, i.e. **H. c. cucullolides** *subsp. nov.*, including corrugated area of aspis; ratio 100.

Hoplophorella varians *sp. nov.*, adult

Fig. 23. Lateral view, legs and mouth parts omitted; ratio 100.
Fig. 24. Dorsoventral view; ratio 100.
Fig. 25. Contact area of anal and genital covers; ratio 200.

PLATE 22

Oribotritia glabrata (22, p. 73), adult

Fig. 26. Lateral view, legs and mouth parts omitted; ratio 100 (unusually small specimen).
Fig. 27. Aspis, dorsal aspect; ratio 60.
Fig. 28. Pseudostigmatic organ, seen from side; ratio 440.
Fig. 29. Anogenital area; ratio 100.

Oribotritia carolinae (17, p. 257), adult

Fig. 30. Lateral view, legs and mouth parts omitted; ratio 60.
Fig. 31. Aspis, dorsal view; ratio 75.
Fig. 32. Anogenital area, plates slightly open; ratio 100.

A NEW SPECIES OF CONRADINA FROM TENNESSEE

By H. M. Jennison

The occurrence in Tennessee of a species of *Conradina* has for years been known to a few plant collectors and others interested in Botany. It is believed that Dr. A. Gattinger, pioneer botanist in Tennessee, knew in a general way of its occurrence in the northern part of the Cumberland Plateau country in Tennessee, but it is doubtful if he ever collected it. At any rate no one of the plants listed in Gattinger's Flora of Tennessee (1901) can be the species in question. The late Albert Ruth, of Fort Worth, Texas, formerly Superintendent of Schools in Knoxville, Tennessee, is reported to have visited the station near Rugby, Tennessee, where this mint grows. Whether he ever collected and distributed it is not known to the writer. Mrs. Charles Brooks, a resident of Rugby, Tennessee, knows where the "Rosemary" grows and has cherished it for many years.

The writer visited Rugby and vicinity about July 1st, 1930, and was guided by Mrs. Brooks to the station where the *Conradina* plants grow. No collections were made at that time since the plants were not in bloom, but on May 16, 1931, the writer, in company with Professor A. J. Sharp, visited the locality again and finding the plants in bloom collected several specimens. Upon critical examination it was discovered that the Rugby plants were not like either one of the 3 species known to science. Additional collections were made and sent to us last summer when further study made it apparent that the *Conradina* in question was sufficiently distinct to warrant describing it as a new species.

At present the writer knows of no station except the one near Rugby where this species grows.

CONRADINA VERTICILLATA sp. nov.

Arbuscula; ramuli passi, radices facile agentes; stamina cylindrata, cortex fulvus, cito cadens; virgulta quadrilatera, rufa, primo puberulentia; folia linearia, fasciculata specie, adversa, margines revolutae, facies dorsalis glabrata, viridis, glandulosa, facies ventralis cana, venxa

media prominens; flores 2-6 in brevi pedicello, fluxis verticillis, vel summo cacumine; calyx hirsutus, validis 13-nervis, labrum superius tribus fibris, inferius bidens, paulo longius superiore; corolla purpurans, labrum inferius 3-fibris (maxime purpurans), maculosum intus, labrum superius fornicatum, retusum; stamina per duo paria, inclusa intra labrum superius, fila curvata, antherae variae, parallelae; genus bifurcum, exsertum; nuculae quattuor, globosae, glabrae; mense Maio floret.

An undershrub with diffuse branches, the lowermost rooting freely; stems cylindrical with brown bark that shreds and sloughs off as the branches enlarge; twigs 4-sided, rufous, at first puberulent; leaves linear, opposite, appearing fasicled, average length 17.0 mm., average width 1.2 mm. (exsiccatae), margin revolute; dorsal surface glabrate, green, glandular-pitted, ventral surface hoary, midrib prominent; petiole inconspicuous, 1 mm. or less in length; flowers 2–6 on short pedicels in loose verticils, or terminal; calyx 6–7 mm. long, hirsute, strongly 13-nerved, the upper lip three lobed, the lower two-toothed and slightly longer than the upper; corolla lavender, lower lip 3-lobed and strongly spotted within, upper lip arched, retuse; stamens in two pairs, opposite, included within the upper lip, filaments curved, anthers versatile, parallel; style forked, slightly exerted; nutlets 4, sphaeroidal, smooth, brown, about 1 mm. in diameter. Blooms in May.

Type, Jennison and Sharp 31–432, collected on sandy beach, north bank of the Clearfork River (Fentress Co.) near Rugby, Tennessee, May 16, 1931, and deposited in the University of Tennessee herbarium. A close relative of the coastal plain species of *Conradina*, but readily distinguished by its verticillate inflorescence and glabrate leaves.

The writer is indebted to Dr. A. W. McWhorter for composing the Latin diagnosis.

DEPARTMENT OF BOTANY,
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FUSION BETWEEN LYMPH BALLS OF A REGULAR SEA URCHIN (LYTECHINUS) AND A SAND DOLLAR (MELLITA)*

By Rebecca Ward

With One Text Figure

The lymph of *Lytechinus* (*Toxopneustes*) *variegatus* (Lamarck) contains five types of cells corresponding to those listed for *Arbacia punctulata* by H. V. Wilson 1924. Reference is made in Wilson's paper to the descriptive accounts of such cells by J. E. Kindred 1921, 1924, Goodrich 1919, and other investigators. A later paper by Kindred, 1926, adds to our knowledge of the Arbacia cells.

It is not necessary to the purpose of this investigation to consider in detail the structure of the lymph cells. The data here set down will suffice. In Lytechinus the lymph contains:

1. Colorless cells with rounded body about 10μ in diameter and numerous pseudopodia. The pseudopodia are doubtless lamellate although with a 4 mm. objective they appear to be filose and 14–18μ in length. These cells correspond to the leucocytes of Goodrich and Kindred.

2. Colorless cells usually elongated and varying in length from 18–25μ. They exhibit amoeboid motion and change of shape without the formation of conspicuous pseudopodia.

3. Red amoeboid cells, quite similar to the preceding in shape and behavior but smaller, measuring 14–18μ in length.

4. Rounded yellowish green cells about 10μ in diameter are present but in small numbers.

5. Spheroidal, doubtless flagellate, cells about 7μ in diameter, which move very rapidly with a rotary motion.

The key-hole sand dollar *Mellita pentapora* (Gmelin), often desig-

* This work was carried on at the Biological Laboratory of the U. S. Bureau of Fisheries at Beaufort, N. C. The writer is indebted to the Commissioner, Hon. Henry O'Malley, for the privilege of working at the station and to the Director and staff for aid and courtesies, and to Professor H. V. Wilson for suggesting the problem here reported on and for his helpful criticism.

nated *M. testudinata* Klein and sometimes *M. quinquiesperforata* Leske, although it belongs to a different order (Clypeastroida) from Lytechinus (Regularia), has lymph cells essentially like those of the latter except that the spheroidal, rapidly moving (flagellate) cells seem not to be present. They were at any rate not observed in Mellita.

"Clotting" of lymph takes place in both species but more rapidly in the case of Lytechinus, probably on account of the greater number of leucocytes in this form, since it is primarily through the activities of these cells that the clot is formed. The clumps of cells produced soon acquire a smooth surface due to the differentiation of a delicate limiting membrane from which pseudopodia are thrown out.

FIG. 1. MARGINAL REGION OF COMPOSITE MASS IN PROCESS OF FORMATION BY FUSION OF LYMPH BALLS OF MELLITA AND LYTECHINUS
The Mellita ball is the darker. Drawn at 3 p.m.

If now, two such masses, one light red and consisting of Lytechinus cells, the other dark red and consisting of Mellita cells, are brought in contact they begin to fuse. The fusion progresses and is eventually complete, the two masses becoming differently colored regions of one continuous whole. In a particular experiment the two masses used were sub-spheroidal, about 0.25 mm. in diameter, and smooth. Using needles and pipette they were brought in contact in a culture dish. Shortly afterwards, at 3:00 P.M., considerable fusion was observed to have taken place. The masses at this time were examined microscopically under a supported cover glass. In one of the reëntering angles and in its neighborhood the pseudopodia of the two masses could be seen constantly changing in 'pseudopodial play' (Fig. 1). Entangled among them and in the meshwork which the two sets of pseudopodia made some free cells, particularly the red amoeboids, could be seen as shown in the figure.

The fusing masses were reëxamined under the microscope at intervals during the afternoon. The plane of fusion was for some hours indicated by a constriction of the whole mass and by a fairly sharp line running across it. This constriction and the line gradually faded out and by 8:30 P.M. had disappeared. The combination mass at this time was ellipsoidal with smooth surface. About one-half of it, representing the Lytechinus tissue, was light red, the other half, representing the Mellita tissue, was dark red.

H. V. Wilson, 1924, has already reported that lymph balls of the two regular sea urchins *Arbacia punctulata* and *Lytechinus* (*Toxopneustes*) *variegatus* will fuse when brought in contact. He remarks upon the contrast in behavior between the sea urchin lymph balls and the, in some respects, analogous reunition balls of dissociated sponge cells. This contrast is intensified by the case here recorded.

LITERATURE REFERENCES

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WILSON, H. V. 1924 Amoeboid behavior of the lymph cells in sea urchins. Jour. Elisha Mitchell Sci. Soc. **40**: 169.

BINARY SYSTEMS OF m-NITROTOLUENE AND p-NITROTOLUENE WITH NAPHTHALENE, p-TOLUIDINE, AND o-NITROPHENOL

By H. D. Crockford and N. L. Simmons, Jr.

In this paper are given the data for the temperature-composition diagrams for the systems: n-nitrotoluene with naphthalene, p-toluidine, and o-nitrophenol and p-nitrotoluene with p-toluidine and o-nitrophenol. This work is a continuation of a series of investigations on the nitrotoluenes which have been carried out in the Department of Chemistry of the University of North Carolina. Data for the system: p-nitrotoluene-naphthalene have been determined by R. Kremann.* From the data have been calculated the heats of fusion of the various compounds.

PURIFICATION OF MATERIAL

The materials employed were the purest grade of Eastman chemicals. The p-nitrotoluene and naphthalene were purified by four crystallizations from hot carbon tetrachloride. Attempts to purify p-nitrotoluene from hot ethyl alcohol were not successful. The m-nitrotoluene was purified by repeated fractional crystallizations from its own melt. The p-toluidine was recrystallized three times from hot carbon tetrachloride and further purified by crystallizations from the molten material. The o-nitrophenol was crystallized four times from hot ethyl alcohol. The following constant melting points were obtained: p-nitrotoluene 51.4°C.; m-nitrotoluene 15.6°C.; p-toluidine 43.4°C.; naphthalene 80°C.; and o-nitrophenol 44.9°C. These values are corrected for stem exposure. It is to be noted that the value for o-nitrophenol is about half a degree higher than the value given by most investigators.

EXPERIMENTAL PROCEDURE

The data were obtained by the cooling curve method. The materials were weighed out into a test tube one inch in diameter. For

* R. Kremann, Sitzungsberichte Akademie der Wissenschaften in Wien. Mathematisch-Naturwissen-Schaftliche Klasse. **113**, IIB: 864. 1904.

the m-nitrotoluene a weighing pipette was employed. This test tube was air-jacketed by a larger test tube which was, in turn, placed in a bath of water, or ice, salt, and water, in a large beaker which was in turn insulated from the surroundings by another air-jacketed beaker of larger size. The whole was covered by asbestos board. In this way the heat loss of the bath during the cooling of the mixture was cut to a minimum. The bath was usually maintained at a temperature about five degrees below the freezing point of the melt. Thermometers graduated in .1/10 degree intervals and calibrated against Bureau of Standards thermometers were employed. Stirring was effected by a glass loop stirrer around the thermometer bulb. All temperature data are corrected for stem exposure. Some trouble was encountered with super-cooling in the mixtures employing m-nitrotoluene as the solvent. By seeding this was kept to a minimum. The method of Bell and Herty* in the interpretation of the cooling curves was employed. This method has been criticized as inaccurate but with a minimum of super-cooling concordant results can be obtained. The data given are easily accurate to .1° and check values were obtained on all solutions (see table 1).

RESULTS AND CONCLUSIONS

An examination of the data shows that all the systems studied are simple ones showing no tendency to compound formation. It was not thought necessary to draw the temperature-composition diagrams. If the values of $\log_{10} X$ (X = mol fraction of solvent) be plotted against the reciprocal of the absolute freezing point of the mixtures, approximately straight lines are obtained in all the cases studied. It may therefore be concluded that these systems are at least nearly ideal in nature. From the slopes of these lines the latent heats of fusion have been calculated. The values obtained are given in table 2.

The values for the heats of fusion show about a two per cent variation in the values obtained for the various melts in any one system except for the values for m-nitrotoluene which show a somewhat greater variation. It is to be noted that the agreement for any one compound from system to system is good except for the m-nitrotoluene. It should be pointed out that this is the lowest melting compound studied, the one in which the smallest number of points was secured in any one system, and the component with which very small errors in melting point would make

* Bell and Herty. J. Ind. Eng. Chem. **11**: 1124. 1919.

TABLE 1

DATA OBTAINED BY USING METHOD OF BELL AND HERTY

MOL PER CENT *p*-NITROTOLUENE	*p*-NITROTOLUENE — *p*-TOLUIDINE	
	Freezing point	Eutectic
	°C.	
100	51.4	—
89.54	45.7	—
78.81	39.2	—
61.77	28.0	15.94
54.54	22.6	15.84
37.31	22.6	15.84
24.49	30.45	—
14.41	36.1	—
9.22	38.9	—
0	43.4	—
	p-NITROTOLUENE — *o*-NITROPHENOL	
100	51.4	—
92.43	47.55	—
82.19	41.7	—
75.26	37.4	—
64.40	29.65	16.9
54.78	22.7	16.9
49.42	18.2	16.9
44.02	19.10	16.9
32.13	27.40	16.9
19.32	35.00	—
6.33	41.75	—
0	44.9	—
MOL PER CENT *m*-NITROTOLUENE	*m*-NITROTOLUENE — *p*-TOLUIDINE	
100	15.6	—
96.49	13.8	—
89.72	10.3	—
81.52	5.4	−2.6
68.79	−.9	−2.7
60.48	2.95	−2.4
44.76	16.50	−2.5
42.07	18.40	—
25.99	29.15	—
25.20	29.65	—
17.45	34.00	—
12.14	37.00	−2.6
0	43.50	—

TABLE 1—*Concluded*

MOL PER CENT *m*-NITROTOLUENE	*m*-NITROTOLUENE — *o*-NITROPHENOL	
	Freezing point	Eutectic
	°C.	
100	15.6	—
90.43	10.75	—
80.28	5.2	—
70.17	.00	−1.45
62.90	3.00	−1.60
49.05	15.50	−1.55
39.09	22.40	—
34.17	25.9	—
24.44	32.0	—
9.58	40.0	—
5.96	41.9	—
0	44.9	—
	m-NITROTOLUENE — NAPHTHALENE	
100	15.6	—
95.74	13.15	—
90.29	9.71	4.6
80.78	4.85	4.8
71.57	17.2	4.6
57.53	35.2	4.9
49.57	43.8	4.85
41.50	51.4	—
29.22	61.3	—
18.91	68.5	—
0	80.0	—

TABLE 2

LATENT HEATS OF FUSION

SOLVENT	SOLUTE	HEAT OF FUSION, CALORIES PER MOL	
		Solvent	Solute
p-Nitrotoluene	*p*-Toluidine	3,970	4,158
	o-Nitrophenol	4,044	4,183
m-Nitrotoluene	*p*-Toluidine	3,365	4,012
	o-Nitrophenol	3,432	4,133
	Naphthalene	3,022	4,384

greatest difference in the heat of fusion calculations. The values calculated are of the same order of magnitude as the calculated values in the International Critical Tables. The value for naphthalene agrees closely with the calorimetrically-determined value in the Critical Tables. However, the values for o-nitrophenol and p-toluidine show about a six percent variation.

SUMMARY

The temperature-composition data have been determined for the systems: p-nitrotoluene with p-toluidine and o-nitrophenol, and m-nitrotoluene with p-toluidine, o-nitrophenol and naphthalene.

The data show that these pairs form simple systems without compound formation. The systems are closely ideal in nature.

The latent heats of fusion have been calculated from the $\log_{10} X - 1/T$ curves.

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Volume 43, Nos. 3 and 4

Frontispiece (in color): Fig. "2" should be "3" and fig. "3" should be "2".

Volume 48, No. 1

Page 85, lines 32 and 33: "To test the absorption of water applied in drops, they sprayed certain wilted plants," should read, "To test the absorption of water applied in drops, Ganong sprayed certain wilted plants," etc.

Line 37: "they allowed young *Helianthus* plants," should read, "he allowed young *Helianthus* plants," etc.

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